Electrical Review

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Motor-Driven Pumps Develop High Efficiency

Tests on Centrifugal Pumps Direct-Connected to Synchronous Motors at McCarren Station Show Exceptional Results

The building of the McCarren pumping station by the Water Department of the City of St. Paul, Minn, made some months ago, involved the installation of two centrifugal pumps with a minimum capacity of 5000 g.p.m. against a total head of 171 ft. The specifications called for an efficiency of 72% and a capacity of 5500 g.p.m. when operating at a total head of 158 ft. It was further required that the driving motors should not be overloaded when working against a head of 140 ft.

Two single-stage, double-suction, volute-type pumps, each having 12-in. suction and discharge nozzles and no diffusing vanes, were installed. They were direcct-connected to three-phase, 60-cycle, 2200-volt; 1200-r.p.m. synchronous motors. The exciters for these units have a capacity of 1.75 kw. and are mounted on the end of the motor shafts.

After installation both units were subjected to complete tests to determine efficiency and head-capacity characteristics. Before the official tests were run the impellers were turned down slightly in diameter, due to the fact that the motors were operating at 20 r.p.m. above rated speed.

Before beginning the test, the pressure gauge of each pump was taken off and calibrated on a dead-weight testing instrument, and then replaced, the pump stopped and the static head of water determined by finding the elevation of the centers of the gauges and the elevation of the

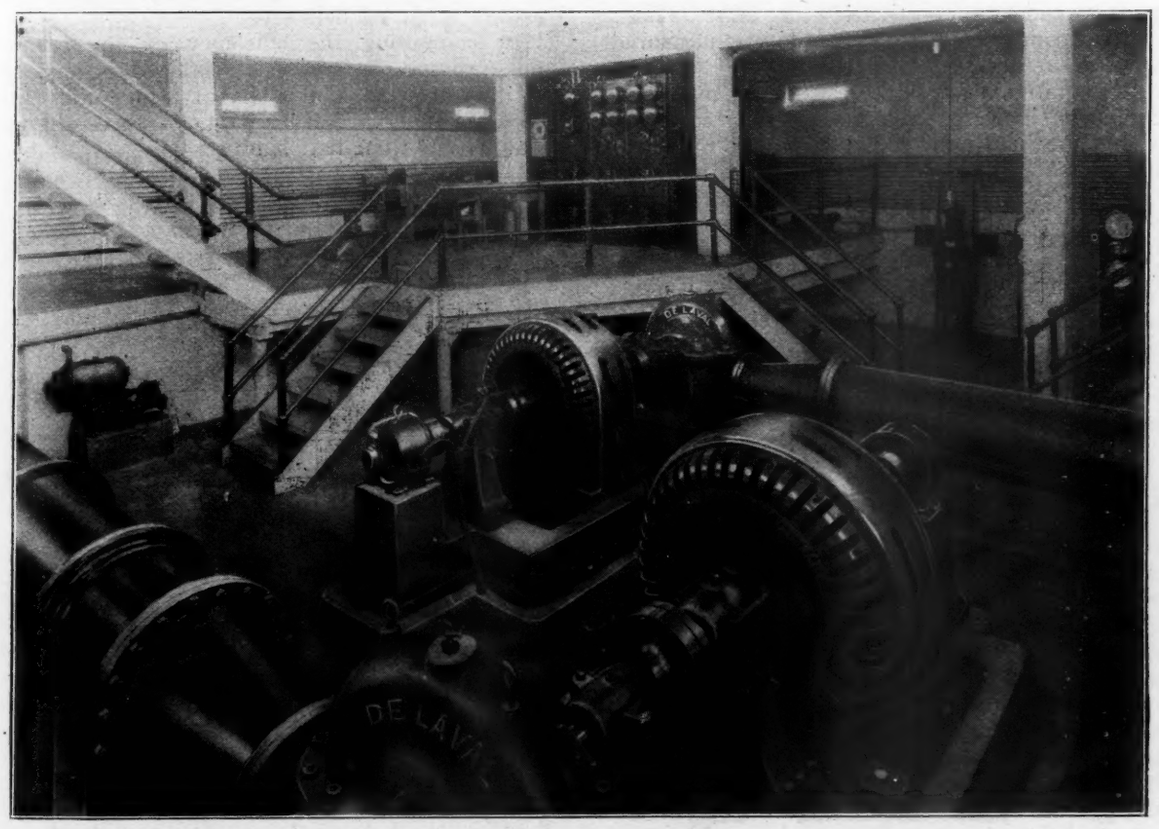


Fig. 1.—Interior of McCarren Pumping Station, Showing Two Synchronous Motors Direct-Connected to Centrifugal Pumps.

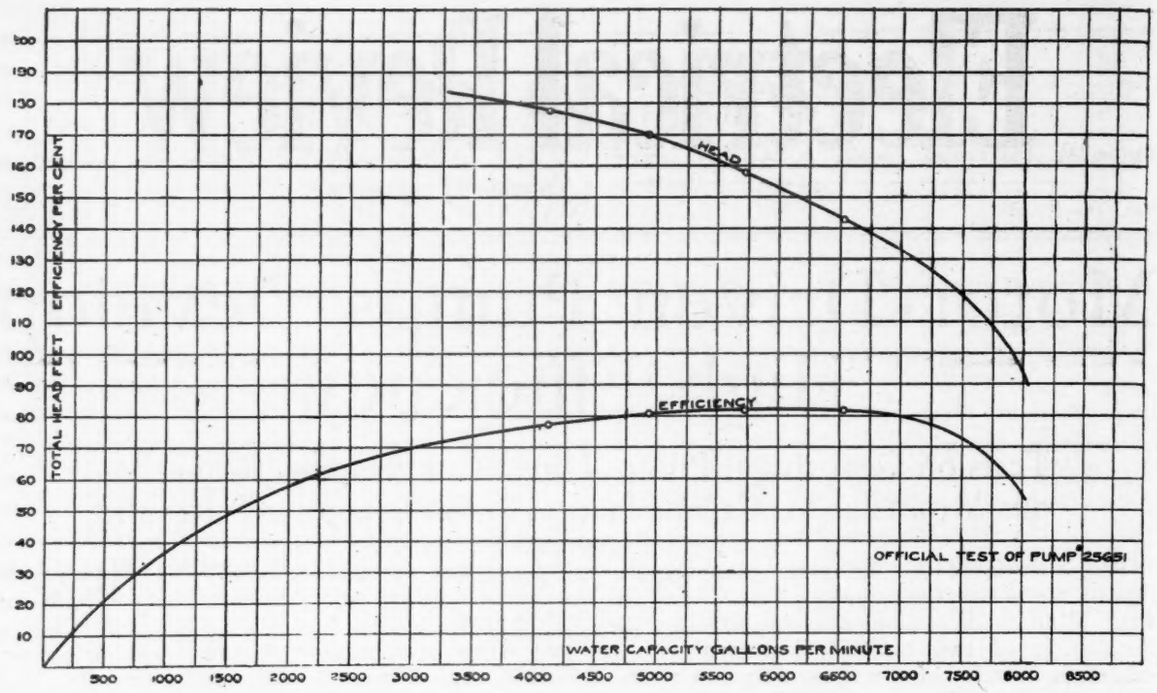


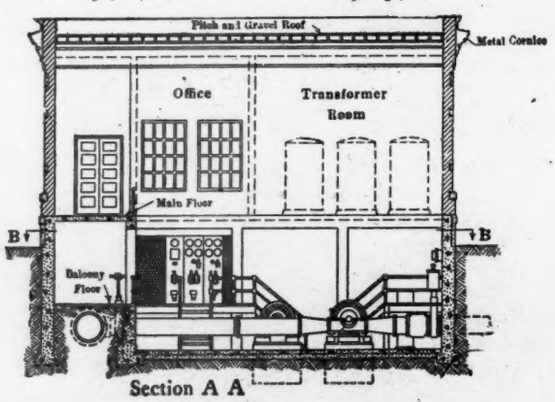
Fig. 2.—Curves Showing Pump Efficiency and Head of Water According to Pumpage of Synchronous-Motor-Driven Centrifugal Pumps.

water in the service reservoir. The head determined from the elevations was found to agree with the calibration obtained with the dead-weight testing instrument. The readings of the suction gauges were also checked against elevations in a similar manner. As they registered zero with no pressure, and, as the variation in head was never more than 10 ft., it was assumed that readings of the gauges between zero and 10 ft. would be proportional.

The quantity of water delivered was measured by a 30-in. by 13-in. Venturi meter. The recording instrument supplied with the meter included an indicating dial, a recording card and an integrating counter, but in order to verify the accuracy of its readings, an indicating mercury manometer was also connected to the pressure pipes of the Venturi tube. The electrical measuring instruments were checked and calibrated by comparison with standard instruments.

In running the test, the head against which the pumps worked was controlled by means of a hydraulic gate-valve on the discharge side of the pumps. After throttling the gate-valve, no readings were taken until all instruments ceased fluctuating, after which two or three readings were made and averaged, if any variations were found. Observations were made with the pumps operating under four different heads, covering a wide range of delivery.

In computing the efficiency of the pumps alone, motor efficiencies, as obtained in tests of the motors at the University of Minnesota, were used as follows: Full load, 95.5%; three-quarter load, 94.6%; one-half load, 92.5%.



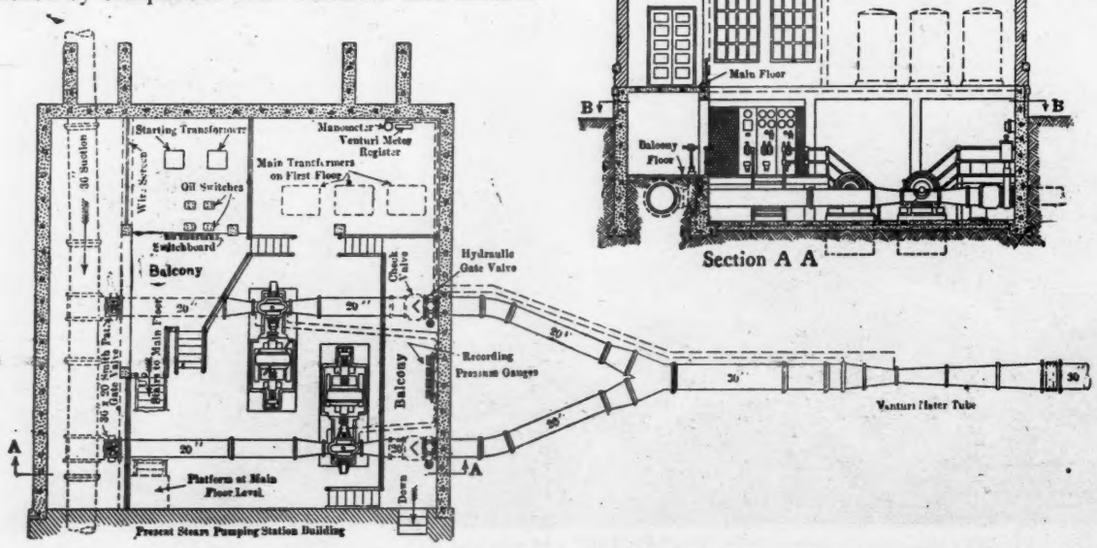


Fig. 3.—Plan and Elevation of McCarren Pumping Station.

The test results of the units show the variations in head and capacity at constant speed, together with electrical hp. input and over-all efficiencies. The efficiencies obtained on these pumps are quite high, considering the comparatively small capacity and the high head. Many builders advocate the use of diffusing vanes for such conditions, which, however, make the pump more expensive and complicated.

Inspection of the curves in Fig. 2 shows that the 72% guaranteed pump efficiency was obtained in actual test over a wide pumpage range. The accompanying tabulated data shows also that there was not an excessive rise in power for the lower heads. It is interesting to note also that 100% power-factor was maintained throughout all tests. This item in itself is sufficient to throw considerable weight in favor of the constant-speed synchronous motors as here used when considering a suitable pump driving unit. The data and curves indicate that the equipment as installed met the service anticipated in the specifications.

RESULTS OF TESTS MADE ON CENTRIFUGAL PUMP DRIVEN BY SYNCHRONOUS MOTOR.

Test No.	1	2	3	4
Voltage	2,250.0	2,260.0	2,270.0	2,295.0
Kilowatt-hours	224.0	217.4	204.8	188.1
Amperes	57.0	56.0	52.4	47.8
Power-factor	100.0	100.0	100.0	100.0
Kilowatts	226.3	220.2	206.0	188.9
Venturi manometer	9.4	8.2	7.1	5.9
Pressure head in ft.	146.5	163.0	176.5	186.0
Suction head in ft.	3.2	5.0	6.5	8.0
Total head in ft.	143.3	158.0	170.0	178.0
Revolutions per min.	1,220.0	1,220.0	1,220.0	1,220.0
Gallons per min.	6,527.0	5,722.0	4,930.0	4,097.0
Water hp.	236.4	228.7	211.9	184.3
Electrical hp.	303.4	295.2	276.1	253.1
Over-all efficiency	78.0	77.5	76.4	72.8
Brake hp.	289.0	280.8	262.2	239.3
Pump efficiency	81.8	81.5	80.7	77.0

The simplicity and convenience of the pump room is shown in the photograph reproduced in Fig. 1. The switchboard is mounted on a low balcony overlooking the entire room. The machines have ample space and are convenient for oiling, cleaning, inspection and repairs.

Fig. 3 shows the general layout of the entire plant, and gives a good idea of the economy of piping for this type of station. The suction and discharge lines are without bends or obstructions and only two gate-valves and one check-valve are used for each machine.

CHANGES BEING MADE IN SEATTLE POWER SYSTEM.

Construction of Skagit Hydroelectric Plant Will Involve Modifications in Transmission and Distribution Systems of Municipal Plant.

Seattle's municipal generating stations and distribution system now afford power and light service to 60,000 consumers within the limits of the city. Its hydroelectric plant, 40 miles east, and its steam-electric plant, in the city, have a combined producing capacity of over 50,000 kw. The former, on Cedar river, is equipped with two units of 5000 kw. each and two of 1500 kw. each; and a new 10,000-kw. unit, which is being installed, will raise that station's capacity to about 23,000 kw. Energy is transmitted from this generating station to Seattle by two 60,000-volt, three-phase lines. The latter, known as the Lake Union steam-electric station, now contains eight Stirling boilers and two 10,000-kw. generating units; and to this equipment a new 10,000-kw. turbogenerator is being added, raising the station's capacity to over 30,000 kw.

The city's Skagit river hydroelectric project has been financed by means of a bond issue, and construction work thereon has been started. The first unit, for which definite plans have been made, provides for a capacity of 36,000 kw. The power site is on Skagit river, 100 miles northeast of Seattle. It is proposed to build a power line to the city that will transmit energy at 160,000 volts. It is proposed that the 45,000-kv-a. generators at this station shall be connected solidly to the transformers through reactors and that all switching be on the high-tension side.

Plans provide for an interconnection of the three plant substations in Seattle by means of 15,000-volt lines. The Cedar river substation is situated in the southern part of the city, with that of Lake Union station near the center. It is proposed to build the Skagit substation in the northern part.

The city is changing its lighting system from two-phase to three-phase as a means of reducing the expense of distribution. As a result of this change there will be no feeder regulators, and the 350,000-cir. mil, 25,000-volt feeders will be replaced by those of No. 2 copper wires strung along the pole tops. One of the anticipated economies will be in the saving of material and another will be a reduction in size of the main substations.

CHICAGO CITIZENS VOTE AGAINST LIGHTING BOND ISSUE.

Chicago voters at the spring election, April 13, defeated the proposition to bond the city for $15,000,000 for the purpose of extending and improving the electric lighting system of the city. The total vote was 140,738 against the issuance of the bonds and 133,028 in favor, the proposition losing by 7710 votes. The lighting bond issue was on the same ballot with issues calling for bonds amounting to $19,500,000 for small parks and playgrounds, memorial convention hall and bridge building, all of which were defeated by much wider margins than the lighting bonds. Had the lighting bonds been voted on alone it is believed the proposition would have received favorable consideration by the citizens.

INCREASED COSTS SHOWN FOR REPAIR WORK.

An English insurance company specializing in power house insurance has issued figures showing the costs of doing identical repair jobs in 1914 and 1919. The following increases illustrate the trend of costs: Rewinding a 2-hp. armature is increased from $25 to $55; rewinding a 5-hp. armature is increased from $32.50 to $70; rewinding a 25-hp. armature is increased from $75 to $160; renewing a crosshead for a horizontal engine is increased from $180 to $430; renewing a valve spindle is increased from $25 to $81.25.

Practice in the Installation and Use of Economizers

Description of the Two Types—Saving of Fuel Accomplished—Advantages and Disadvantages of Economizers—Points in Connection with Installation—Factors Entering Into Their Successful Operation

Of all necessary equipment in the boiler room the economizer has the oldest history and, in many ways, has the most secure position. It was in 1845 that Edward Green developed economizer design and construction to a point of practical utility, and the apparatus has been in more or less general use ever since. Curiously enough, America, with her apparently insatiable demands for industrial efficiency, has never adopted the economizer to anything like the extent which Europe has, nor has she accorded it,

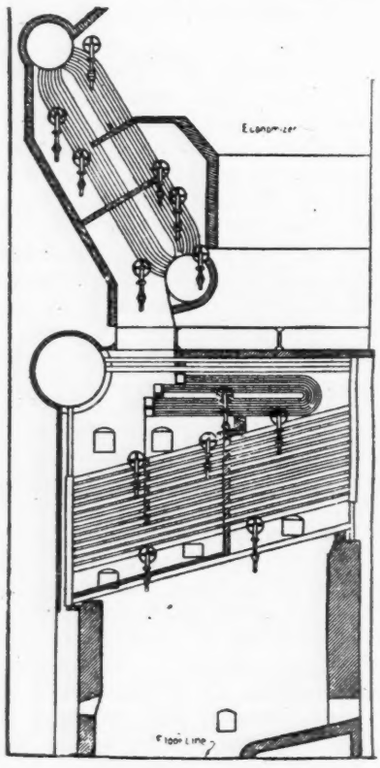


Fig. 1.—Integral Type of Economizer.

when adopted, the degree of appreciation and recognition to which it is entitled on merit. For the economizer does possess merit in many ways which we shall discuss, sufficient to recommend it to thousands of power-plant operators whose boiler rooms are not now equipped with them.

Types of Economizers.

Economizers are of two types. The integral type is directly connected to the boiler, and the independent type is so designated because it is not exactly connected to the boiler.

Fig. 1 is a good example of the integral type. The installation, which is to be found at the plant of the Kansas City Light & Power Co., consists of six Babcock & Wilcox boilers, with economizers, built of standard drums and tubes of Sterling boilers, super-imposed. The use of Sterling boiler sections saved time in delivery, reduced cost, and at the same time satisfied the requirements imposed by the operating pressure, which was 300 lbs.

Figs. 2 and 3 (reproduced by courtesy of Prof. G. F. Gebhardt) illustrate the independent type, as exemplified by the Green economizer. The Sturtevant economizer, while differing in some details of design and construction, is of the same general type and need not be separately described —it being understood that superior merit is not here assigned to either equipment, with reference to the other.

The independent economizer consists of rows of cast-iron tubes arranged vertically and in sections. The tubes are usually 9 to 10 ft. high and 4⅝ ins. in diameter. Sections of decreasing width are arranged across the main flue between the boiler and the stack, so that the gases of combustion must pass through the spaces between the tubes on their way to the atmosphere. A by-pass is provided for use when the economizer is down for cleaning or repairs, so that boiler operation need not be interfered with.

Top and bottom headers connect the various rows of tubes, and the headers are themselves connected to upper and lower branch pipes. Feed water, on the way to the boiler, is forced through

TABLE I.

Absolute Pressure Lbs. per Sq. In.	Temperature in Deg. F.
100	327.6
110	334.5
120	341.0
130	347.1
140	352.8
150	358.2
160	363.4
170	368.3
180	372.0
190	377.4
200	381.7
210	385.8
220	389.8
230	393.6
240	397.3
250	400.9
260	404.4
270	407.8
280	411.1
290	414.3
300	417.4
325	424.8
350	431.8

the various sections of pipe, beginning near the stack, at the point of lowest temperature, and leaving near the entrance to the economizer, at the point of highest temperature.

Without the economizer, the lowest limit to which the temperature of the flue gases leaving the boiler may be reduced is, of course, the temperature of the steam, which is dependent upon

the pressure. This is shown in the accompanying table.

What the Economizer Does.

The economizer takes in feed water at a temperature ranging from 50 to 200 deg. F. and delivers it to the boiler at a temperature of 100 to 150 deg. higher, utilizing the heat of the flue gases which would otherwise be dispersed up the stack to the atmosphere. This statement indicates there is an excellent opportunity to effect economies in operation well worth investigating.

With the economizer the lowest practicable limit is that of the dew point of the exit gases. Under average conditions of boiler operation, only about 85% of the possible reduction between initial furnace and outlet gas temperatures can possibly be obtained. To obtain 95%, it has been calculated that the boiler heating surface would have to be increased by 60%. The impracticability of any attempt to gain economy in this manner is evident by a glance at the conditions of combustion.

When the combustion gases first come in contact with the surfaces of the boiler, the transfer of heat is very rapid, due to the great difference in temperature. As the gases in their progress become cooler, the rate of transfer declines proportionately. If carried far enough, a point is reached where the amount of heat transferred per square foot of boiler surface is not sufficient to pay interest, maintenance and operational charges upon the surface involved. The calculation to obtain the minimum point is somewhat involved and need not be entered into here, it being sufficient to note that with coal at $3 per ton it ranges from 100 deg. F. difference between steam temperature and flue gas temperature if boilers are operated at 24 hours a day, 365 days a year, to 250 deg. F. difference if boilers are operated 10 hours a day, 300 days a year. We may assume 150 to 200 deg. difference as the minimum in the average case. This means, finally, that economical over-all boiler efficiency

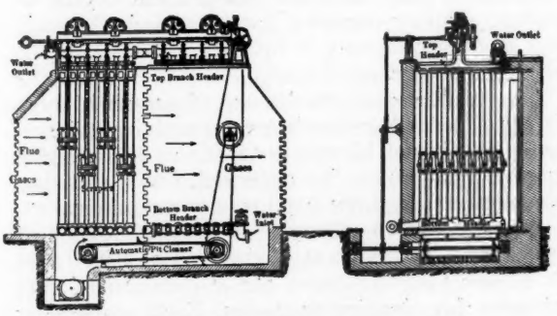


Fig. 2.—Independent Type of Economizer.

is strictly limited, unless some cheaper means can be found, such as afforded by the economizer, of transferring the heat to the water.

To take an example from actual practice, let it be assumed that a boiler operating at 180 lbs. pressure has been provided with sufficient heating surface, as is often the case, to reduce the flue-gas temperatures to 560 deg. F. Assume water to enter the economizer at 90 deg. F., that the temperature of exit gases from the economizer is 350 deg. F., and the water to be heated 150 deg. F. The average temperature of gases in the economizer is one-half of 560 plus 350, or 455 deg., and of the water is one-half of 90 plus 240, or 165 deg., giving an average difference in temperature of water and gases of 290 deg. This is 1.6 times as great as the difference

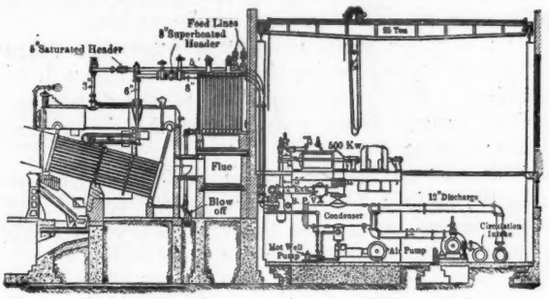


Fig. 3.—Another Type of Independent Economizer.

in temperature between the gases in the last pass of the boiler and the steam. Hence it follows that the economizer surface as a whole will recover 1.6 times as much heat per square foot as will the last square foot of boiler surface.

Outline of Advantages and Disadvantages of Economizers.

The advantages of economizers may be enumerated as follows: (1) A saving of 5 to 15% in fuel is obtained. (2) A substantial gain in overall efficiency results when the boilers are forced and mechanical draft is employed. The highest possible gain occurs when boilers are operated 200% or more above rating, using mechanical draft and with electrically driven auxiliaries, precluding a supply of exhaust steam being available for feed-water heating. (3) Decreased strain on boilers results, due to higher entering temperature of feed water. (4) The large storage of hot water makes it easier to handle sudden peak loads, giving increased flexibility.

The disadvantages of economizers include: (1) The initial cost is comparatively high, being in the neighborhood of $12 per boiler hp. (2) The maintenance is comparatively high, involving repair costs due to soot-scraper replacements. (3) An actual loss in overall efficiency results when the installation is made in connection with light chimney draft and boilers operating below normal. (4) The equipment is bulky, taking up considerable space. On new installations, a larger boiler room than otherwise required must be provided; in old boiler rooms, installation can only be made at considerable expense for alterations.

Points in Connection with Installation.

Points to be taken into account when considering the installation of an economizer are as follows:

The higher the flue-gas temperature the greater will be the economies effected.

If the boiler pressure is 250 lbs. or over economizers are indispensible.

The use of an economizer proves to be more necessary as the load conditions on the boiler increase.

In some cases an economizer is desirable even

with an initial feed water temperature of 200 deg. F.

If the use of electrically driven auxiliary eliminates exhaust steam as a possibility for heating feed water, an economizer is desirable.

With impure feed water the formation of scale inside the economizer tubes may seriously affect the efficiency of heat transmission.

If a chimney draft is depended upon, an extra height of stack, costing from 20 to 40%, will be required. With mechanical draft, the power required ranges from 1 to 4% of the main generator output.

The cost of installation of an economizer increases rapidly for operating pressures of 250 lbs. or more, on account of extra heavy materials required.

Gas Temperatures.

It is important to know the temperature of the gases entering and leaving the economizer.

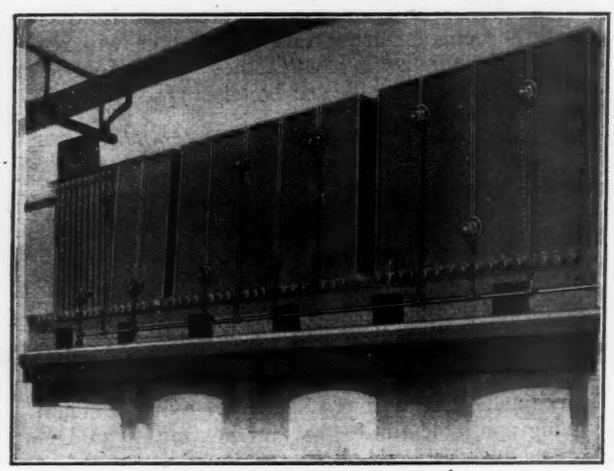


Fig. 4.—Mechanical Soot Blowers Adapted to Independent Type of Economizer.

Either a mercury thermometer or an electric pyrometer will answer the purpose. A recording instrument is preferable, since a permanent record is made to which reference may be made at any time. By means of this record the losses caused by infiltration and dirty tubes may be determined at any time.

In inserting the pyrometer tube, locations at the entrance and exit points of the gases should be carefully taken. The tube should not be placed behind the damper or anywhere else where there is likely to be a pocket of dead gas. A point in the middle of the flue should be chosen, and care should be taken to make sure that the hole through which the instrument is inserted is sealed tightly about it, so that there will be no air infiltration at this point with consequent errors in records, as well as loss in efficiency.

Water Temperatures.

Mercury thermometers placed in the inlet and outlet pipes will show the water temperatures. Recording thermometers are preferable for this service, both from the standpoint of accuracy and efficiency of operation.

The function of the economizer is to heat the feed water and without continuous temperature readings the operator in charge has no idea what results are being secured. It is not desirable from a mechanical standpoint to operate an economizer under conditions such as would cause steam to form in the economizer itself, yet this condition might arise with either a slight increase in the temperature or an increase in the weight of the waste gases passing through the apparatus.

Air Infiltration.

Due to the peculiar construction of heaters, dampers, section walls, etc., the economizer offers many opportunities for air infiltration. Frequent checks should, on this account, be made of the entrance and exit temperatures of both gas and water, and frequent analysis should be made of the CO_2 in the entrance and exit gases. A drop of 1 to 2% in the CO_2 through the economizer may reasonably be expected, but where the drop exceeds this amount something is wrong and rigid investigation should be made.

In searching for air leaks a torch or candle should be used, and particular attention paid to cleaning doors, damper shafts and the walls of the gas flue between the economizer and the boiler. It should not be taken for granted that low exit-gas temperatures mean efficient economizer operation. Constant checking, particularly of CO_2, is the only safeguard.

Cleaning of Economizers.

Due perhaps to lowered temperatures and slower movement of the gas, there is a great tendency toward soot deposit on economizer tubes. As soot is the best preventive of heat transference known, being several times more effective than asbestos in this respect, it must be removed. When scrapers are used, each tube is encircled with a set of triple overlapping scrapers which travel continuously up and down the tubes at a slow rate of speed. The apparatus for working the scrapers is placed on top of the economizer, outside the chamber, and the motive power is supplied either by a belt from some convenient shaft or small independent engine or motor. Power required for operating the gearing is approximately 1 hp. per 1000 sq. ft. of economizer surface.

As an alternative to the use of scrapers, there is the standard cross-element, revolving type of mechanical soot blower. As far as the integral type of economizer is concerned, the mechanical soot blower has been used to a great extent.

Fig. 1, which shows the integral type of economizer at the plant of the Kansas City Light & Power Co., illustrates the application of soot blowers for cleaning purposes. Each economizer has six soot blower units, with nineteen nozzles each, on each side. Six minutes of actual blowing time is required to blow the soot from the economizer, and the steam consumption is about 2600 lbs.

Fig. 4 shows the adaptation of mechanical soot blowers to the independent type of economizer. With revolving units permanently installed between the tubes and regularly used several times each day, the heat-resisting soot is given but little opportunity to collect. The tubes are kept clean and consequently the general efficiency of the economizer is very greatly improved.

Electrically Operated Gate-Valves

General Considerations in Regard to the Use of Power-Operated Valves, with Data on Their Application in Power Plants, Description and Discussion of Types Developed for Commercial Use

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Judging from the absence of electrically operated valves in large power and water plants, it seems that their application and use has been somewhat overlooked. There seems to be a legitimate reason for this fact. Valves are a small part of the power engineer's equipment, and their choice receives no undue consideration from him. If he is sufficiently interested he calls for power operation of valves, but, if not, the valve salesman seldom calls attention to the advantages. Until the last year or so use of power-operated valves has been meager.

The valve manufacturers are essentially mechanical engineers, invariably occupied with quantity output of iron and steel, and the applications of electricity are quite foreign to the majority of them. Seldom do they employ electrical men other than factory electricians, and therefore depend upon outside aid and the motor manufacturers for information as to the proper type of motor and control.

On the other hand, motor manufacturers seem to express little interest in the subject, since the demand is not sufficiently large to warrant special designs being prepared, and the net result is that the valve man is left entirely to himself to secure the proper control equipment.

The control gear, such as switches, limit mechanism, etc., involves numerous problems, and to be successful the application, as a whole, necessitates careful study by engineers familiar with valve construction and use, and also familiar with the application of electric motor control.

Assuming that the engineers are able to purchase a successful control, a still greater problem arises as to where such valves can be successfully used without going to the extreme. Steam lines and water lines necessitate hundreds of valves—many of equal importance. Since cost prevents motor operation in every case, careful study must be made of the economical use of electrically operated valves, and without reference to their importance, size and location, the following outline will show the advantages of their use in specific locations.

Application to Power Stations.

The high-pressure steam header probably merits first consideration, especially in view of the extremely high pressures and the high superheat generally used. Valves in these lines are necessarily placed in rather inaccessible locations quite a distance from the boiler-room floor, and it is a noticeable fact that platform galleries are very often omitted. Whether operated by power or by hand, it is highly essential that means be provided to reach every valve without ladders or scaffolding.

In the modern central-station, the most important valve is the one situated in the turbine lead, between the header and the turbine throttle. This valve is usually from 16 to 20 ins. in diameter. The throttle is usually of the emergency trip type and, in case of failure or sticking, a quick-closing lead valve is a necessary protection to the turbine in case of over-speeding or a line fracture.

Hand operation of such a valve takes two men about 5 minutes, depending upon its accessibility, whereas electrical operation in 30 seconds from one or more safe points is the surest means of protection against loss of life and complete shutdown of the station.

Highly superheated steam of 325-lb. pressure provides its own argument for the maximum protection of the lines, which is, of course, impossible without power-operated valves.

Sectionalizing header valves is also of considerable importance, and a well-designed control scheme allows of flexible handling of the complete system from a thoroughly safe operating point.

Next of importance in a large power plant are the water circulating valves between the pumps and condensers. These usually run from 24 to 54 ins. in diameter and convenience alone easily justifies the use of power operation, since closing by hand requires from 20 to 40 minutes.

Application to Waterworks.

In waterworks installations and distribution systems, the valves are quite large and take considerable time to operate. Motor operation on the pump discharge valves and on the principal valves around the pumping station would result in the saving of an enormous amount of time and labor. In filter plants, power-operated valves have been more frequently used, as these call for frequent operation.

Power operation of large distribution valves for waterworks is seldom given any attention, despite the fact that enormous losses are sustained each year due to breaks in the water mains with no quick means available for stopping the flow. These valves form a particularly good argument for power control on account of their size and location and the physical effort necessary to operate. Distribution mains in large cities usually run through congested districts where a bad break would cause considerable damage. An instance of this was where the main transportation system of a large city

was entirely suspended for nearly a day due to flooding from a fractured main.

It is of interest to note that the city of New York has in operation nearly 3000 mi. of water mains, exclusive of high-pressure fire service, necessitating some 66,350 gate-valves ranging in size from 4 to 60 ins. and including some 700 valves of 24-in. diameter and above.

Application to Dry-Docks.

Power operation of flooding and unwatering valves and sluice gates used in floating dry-dock operation is being given considerable attention by dock engineers. A 20-ton sectional floating dry-dock contains anywhere from 36 to 72 valves of from 12 to 24 ins. diameter, which are submerged and operated from floor stands on the deck some 40 to 50 ft. above. In order to raise and lower a boat the valves must be operated in numbers, formerly requiring several men, to whom instruction had to be given by the dock master in charge of the operation. The modern scheme is to place the control of the complete plant of valves and pumps at one control station, so placed that a good view of the complete dock operation is obtained. This not only saves considerable time, but eliminates the possibility of misinterpreting signals and allows a boat to be raised on an even keel, without danger.

Application to Refrigeration.

Electric control of ammonia valves has been but little employed, but their use is of the utmost importance on account of the deadly effect of ammonia gas. In case of a bad leak of ammonia, it is dangerous to remain in the atmosphere even long enough to close the valves. In some cases, to provide for such an emergency, the ammonia pipes are brought to the street and there provided with valves that can be operated from the outside.

Application to Oil Refineries.

Valve houses in oil refineries, containing some hundreds of oil distributing valves, provide an important application, since the pressure is usually extremely high and such control would provide means for isolation in case of fire.

Description and Discussion of Valves.

The standard kinds and makes of modern valves are generally known, so that this discussion will relate only upon those adaptable to power operation and will not include valves of the non-return, globe, throttle, atmospheric release or check type.

For high-pressure steam lines use is made almost entirely of cast-steel, outside-screw and yoke gate-valves which are made in three patterns, namely, the solid disk or taper wedge, the tapered-seat double disk, and the parallel-seat double disk. The Ferranti or Venturi type is also used to some extent. The body, bonnet and gate are of cast steel, while the seat and seat rings, together with the stem, are of "Monel metal," which is ideal for high temperatures. The latter is noncorrodible and has a melting point of 2480 deg. F., besides possessing a tensile strength of 70,000 lbs. for cast metal and 105,000 lbs. for rolled metal. Such valves are constructed for a working pressure of 350 lbs. and a total heat of 800 deg. F.

One cannot always account for the choice between the use of the solid-wedge and the double-disk type of steel valve, and their selection seems to be governed by the experience of the purchasers. It seems curious to note that while some manufacturers are discontinuing the manufacture of solid-wedge valves, others are producing new patterns and strongly advocating their use.

The solid-wedge valve has the advantage of a small number of parts, but it requires very careful workmanship on the seat and seat rings in order to be tight. A slight difference of expansion of the "Monel metal" rings is also apt to cause a leaky valve.

Valves of double-disk construction, having pivoted disks, adapt themselves to the seats and with the aid of the pressures usually remain tight and, in my opinion, the pressure on the disks does far more toward keeping any gate-valve tight than any form of wedge or wedging mechanism. Maximum pressure always exists between the disks and forces the farthest one to a tight seat.

During the course of some experiments with this type of valve, it has been found possible to release the wedging mechanism completely by turning the hand-wheel one revolution towards opening, with full pressure on one side of the disk and without the valve showing any sign of a leak—which clearly demonstrates that pressure alone makes it tight. In this case it is noted that one manufacturer of high-pressure steel valves lists a parallel-seat valve having two loose disks with no means except the pressure to keep them tight against the seat.

Low-pressure cast-iron valves are used entirely for circulating condenser water and are built to stand about 20 lbs. pressure per sq. in.

The inside-screw and the outside-screw and yoke types are used, being of cast iron with bronze seat and seat rings and manganese-bronze stem. These are usually of the parallel-seat type.

Another similar type of valve used in turbine installations is the atmospheric outlet gate-valve, which is used between the turbine and condenser to serve the purpose of a gate-valve and tee for the free-exhaust connection. While this type of valve is not frequently operated it, nevertheless, lends itself quite freely to the application of electrical operation.

For waterworks both standard and extra heavy cast-iron, bronze-mounted valves are used. These are of the inside-screw type and usually geared to reduce the turning effort. These usually lie on one side and the gates, which are usually double, operate on rollers and guides.

Of the two remaining types, the single gate-valve is used under light pressure and where the pressure is in one direction, as in sewers, vats, etc. The ordinary sluice-gate is used for outdoor operation.

Types of Power Operating Devices for Gate-Valves.

There are three types or kinds of power operating devices for gate-valves: namely, hydraulic, electric and the water motor. The piston or

hydraulic cylinder valves may be used with steam, air or water, the latter medium being considered best for general purposes. The cylinders are of cast iron and are brass lined, carrying the ordinary hydraulic plunger, and pressure is admitted either above or below the piston by a four-way cock or valve. Remote or distant control of these valves is obtained by using magnetically operated control valves connected to a source of energy such as a power circuit or batteries. In case of the failure of water pressure, provision is sometimes made to attach a stem and yoke so that ordinary hand-wheel operation can be secured.

While this type of valve is extremely simple in construction and operation, it is not suitable for outdoor usage on account of the possible freezing of the liquid; furthermore, the cylinder cannot be applied to existing hand-operated valves and, on account of the size of the cylinder, it takes up considerable room. For filter installations and where no electric power is available, this type of valve is, of course, ideal.

The water motor has been used in this country to some extent, but not with any marked degree of success. This type of motor consists of an ordinary Pelton wheel encased in a cast-iron casing and supplied by pressure from the water main itself. The wheel is of the non-reversing type, and in order to operate the valve in both directions an ordinary reverse gear is arranged which must be manually operated.

This valve also freezes unless it is drained; furthermore, it is very cumbersome on account of its size. It is not applicable to existing valves without considerable alteration, and since it has no limit device to disconnect the power when the valve is seated it frequently jams; furthermore, it cannot be controlled from a distance.

Electrical operation by the aid of a motor geared to the valve-stem and a limit switch for stopping the movement is by far the most reliable method but, of course, presents more of a problem. The principal difficulty is to confine the movements of the valve gate within any precise limits, especially at the closed position. On account of the momentum or overtravel of the motor armature and driving gears, after disconnecting the circuit, it is easily seen that these limits are not easily obtained unless, of course, some quick stopping device such as a solenoid brake is used on the motor shaft. The movement must be accomplished by an electric motor driving the valve steam through reduction gearing, and when the motor has driven the valve gate firmly but not too tightly into its seat, it has to be disconnected by some form of limit switch that is also geared to the valve stem and set to bear a definite relation to the position of the valve gate at all turns. Of course, the armature and gears have considerable momentum and consequently the limit switch has to be set to stop the motor, so that this overtravel will carry the gate tightly into the seat. In other words, energy stored up in the moving parts is relied upon to form a tight seat. The momentum of the armature and gears after being disconnected from the circuit depends upon friction between the moving parts and the packing in the stuffing gland and also upon the pressure on the valve disk, all of which are very uncertain quantities.

If a valve limit is set to close tightly, without pressure on the disk, and with normal or loose stuffing-box, it is easily seen that the limit may have to be changed for actual operating conditions, such as tight stuffing-box and full pressure of the valve disk. In other words, the added friction would be so great as to allow of only a very small overtravel, and consequently the valve would not close tightly. If a solid-wedge type of gate-valve is carried too tightly into its seat it soon upsets the bearing between the gate and the seat ring, with the result that the valve cannot be made to close tightly. It is easily seen, then, that the apparatus required to fulfill these conditions must be specially constructed.

Requirements of Motors for Operating Valves.

The motor is chosen entirely with relation to its starting torque, which must be very high in order to unseat a tight valve gate. It must run at a fairly low speed not exceeding, say, 750 r.p.m., both on account of the gearing to the valve stem and because of the armature momentum which must be kept to a minimum to enable a quick stop and to prevent jarring. The motor must be moisture proof for practically every application, not forgetting the extreme heat to which it will be subjected when operating on high-pressure superheated lines. The temperature in which the motor is expected to operate often reaches 200 deg. F., so that special care must be given to the insulation to withstand this, or deterioration will take place. The machine must be made to work in any position, the bearings being either ball-bearing or of the self-lubricating "Metalline" type. The d-c. winding is usually series or compound, the latter being used so as to prevent an excessive speed of the valve disk after it is unseated. Polyphase a-c. motors are preferable to the single-phase type on account of the poor starting characteristics of the latter. For a given size of valve, the a-c. motor has to be nearly as large as the d-c. machine because the former machine possesses a much weaker starting torque per pound of weight.

The limit switch has to be of the quick-break type capable of being immediately reset after breaking, so as to reverse the valve at any intermittent point. It should be geared directly to the valve stem, so as not to be upset when the valve is operated by hand.

The controller may be either a plain reverse switch or a panel with indicating lights, to throw the motor across the line without any starting resistance.

These three units, well chosen with regard to their ability to operate together, and applied to a valve, constitute with the reduction gears a most reliable and efficient motor operation and the most nearly perfect that has been developed. This system has its limitations, however. It cannot be standardized and its use is confined to new installations only, since it cannot be applied to valves already in use without shutting down the line. Equipment of a given make necessitates different yokes, bonnet castings and gear ratios to suit the motors; thus, when a different make or speed of motor is used the castings and patterns have to be altered. The motors have to be

bolted directly to the yoke which on superheated lines is usually extremely hot, and such heat is transmitted through the field frame to the windings with damaging effect.

Different makes of limit switches and panels are used for short and long-distance operation as well as for d-c. and a-c. power supply, so that it is apparent that no standard can be adopted, especially as engineers frequently specify different makes of motors and controllers.

Valve Device to Fulfill Operating Conditions.

Some three years ago the writer began a careful study of the situation, confining himself entirely to valves and their operation, with the object of designing and building a valve-operating device to fulfill every condition of operation. The Dean system of valve control, which is the outcome of these observations, is built on somewhat radical lines incorporating four special features: (1) It can be attached to existing valves with a medium of effort and without shutting down the line; (2) it is positive in operation and does not depend upon momentum or drift of moving parts to seat; (3) it has ample unseating and seating torque, and (4) the whole unit is inclosed and waterproof.

The system consists of a single unit in which are incorporated the driving motor, reduction gear and limit trip mechanism. The feet of the unit are provided with four holding-down bolt holes of standard dimensions for a given range of valves. Four standard units cover the complete lines of valve sizes in use.

The motor is totally inclosed and waterproof and possesses an extremely high torque. It is connected to a system of combination worm and planetary gearing for the necessary reduction in speed. The motor speed is normally 1600 r.p.m. and that of the low-speed shaft 40 r.p.m., the gear reduction being 40 to 1. With different gear ratio incorporated in the same casing a reduction of 120 to 1, or 14 r.p.m. on the low-speed shaft, is available.

The motor shaft is coupled to the worm shaft, both running in ball-bearings, and the worm-wheel is keyed on to a sleeve forming the sun pinion of a planetary gear. The planet pinions revolve on large studs forced into a flange on the low-speed driving-shaft and these pinions mesh into the internal gear forming the outer member of the planetary. The outer planetary member is provided with two external grooves extending clearly around the surface, each one being provided with a stop. The external member fits into a bearing surface in the casing and is locked in place and prevented from turning by two movable driving plugs extending through the casing and into the grooves.

The valve gate is made to seat tightly, under power and to a predetermined point, drift and overtravel being entirely disregarded as a means of seating the gate.

The gearing for speed reduction is encased in a cast-iron housing partially filled with oil so that the gears are always well lubricated.

The limit mechanism is contained in a separate part of the housing and provided with removable cover. A noteworthy feature is the total absence of exposed cables and wires, these being encased in conduit and the joints made waterproof.

For changing a hand-operated valve to power operation the unit is ideal on account of its compactness. The outside screw yoke valve necessitates only two pads, welded onto the yoke to suit the feet of the unit and drilled, while the hand-wheel is replaced by a cut gear which is keyed onto the same bearing. A shaft extension is provided for the hand-wheel when necessary.

Valves of the inside screw type do not afford much facility for change, especially those with only one bearing, since this bearing is usually too small to withstand the thrust of a power driven gear.

Control of the valves is by means of one standard control station for one or more points. Stations are fitted with indicating lights and provision is made for locking the operating handle to prevent unauthorized operation. For multiple point control, use is made of a totally inclosed relay panel, which is necessary in order to prevent a short-circuit should two or more stations be operated at one time.

A NEW FORM OF VIBRATION GALVANOMETER.

Vibration galvanometers are useful in null measurements but have not been used in industrial laboratories because they are sensitive to external vibrations and require delicate adjustments. The present instrument, which has a sensitivity higher than other forms of the moving-iron type but less than that of the most sensitive forms of the moving-coil type, has the advantages of sturdiness, quick responsiveness and freedom from the effects of external vibration. It consists essentially of a fine steel wire mounted on one pole of a permanent magnet and so arranged that the free end of the wire may vibrate between the poles of an electromagnet through which the current to be detected passes The instrument is described in Bulletin No. 370, issued by the United States Bureau of Standards, Washington, D. C.

PUGET SOUND COMPANY CHANGES ITS NAME.

The Puget Sound Traction, Light & Power Co., Seattle, Wash., has shortened it name by dropping "traction" from it and is now known as the Puget Sound Power & Light Co. Since the sale of the Seattle street railway lines operated by the old company it has been concentrating on power and light business, hence the change in name. The company does an electric light and power business in 142 communities in the Puget Sound basin, the territory covered extending from the Canadian boundary at Sumas to Olympia, Wash.

KANSAS CONTRACTOR-DEALERS TO MEET APRIL 26-27.

The semi-annual meeting of the Kansas State Association of Contractors and Dealers will be held in Kansas City, Mo., on April 26-27, in connection with the meeting of the Missouri State Association of Contractors and Dealers. William L. Goodwin and Samuel A. Chase will be the principal speakers at the meeting.

Steel Transmission Line Towers

Reactions for Towers Located on Steep Grades—Stringing Wires on Grades—Discussion of Relations Existing Between Stress, Temperature and Sag in Transmission Lines—Thomas' Sag Calculations

By E. L. GEMMILL

Chief Engineer, Transmission Tower Department, Blaw-Knox Co., Pittsburgh.

This is the third of a series of articles by Mr. Gemmill on the subject of steel supports for transmission lines, the preceding articles appearing in the March 6 and April 3 issues of ELECTRICAL REVIEW. In this article theory pertaining to reactions at points of supports for spans on inclines is given, together with the relation between stress, temperature and sag in transmission lines and a review of Thomas' sag calculations. The succeeding articles will give modern practice in the design, spacing and installation of towers.—EDITOR'S NOTE.

When wires are strung on towers located on steep grades, it is necessary that the reactions at the points of support be carefully determined, and also the deflection of the wire away from a straight line joining the two points of support for any given span. This case is shown in Fig. 8.

If the horizontal distance l between the supports A and B and also the vertical distance h that B is above A is given, together with the maximum tension T in the wire at the point of support B, the reactions at both of the supports and also the sag in the wire can be determined.

The wire ADRB is in equilibrium under three forces, viz., the tensions acting at A and B in the directions of the tangents, and its weight wl^1 acting at its center of gravity. These three forces intersect at the point Z, and the vertical line through this point passes also through the point C on the line AB and midway between A and B. On this vertical line lay off the distance OU equal to W or wl^1, and let it be bisected at the point C so that OC equals CU or $\frac{1}{2}wl^1$. Complete the force diagram by drawing UV and OV parallel, respectively, to ZB and AZ. UV will then be the tension in the wire at the point B, and OV will be the tension at the point A. The vertical component of the reaction at B is the vertical component of UV and is equal to UM. The vertical component of the reaction at A is the vertical component of OV and is equal to MO or UO — UM.

Complete the parallelogram of forces by drawing OF parallel to UV and FU parallel to OV. The points F and V must lie on the line AB. Let the tension UV in the wire at the point B be denoted by T. Let θ be the angle made by the line AB with the horizontal line AX, and let ϕ be the angle between the lines FO and AB. Let β be the angle which the tangent at the point B makes with the horizontal plane.

Angle $OCF = \theta + 90°$.

$$\sin\phi = \frac{OC}{OF} \times \sin\,(90° + \theta) = \frac{wl^1}{2T}\cos\theta$$

But $l^1 = l/\cos\theta$, and therefore $\sin\phi = wl/2T$.

$$\beta = \theta + \phi = \theta + \sin^{-1}(wl/2T).$$

The horizontal component of the stress in the wire at either point of support is $H = T\cos\beta$.

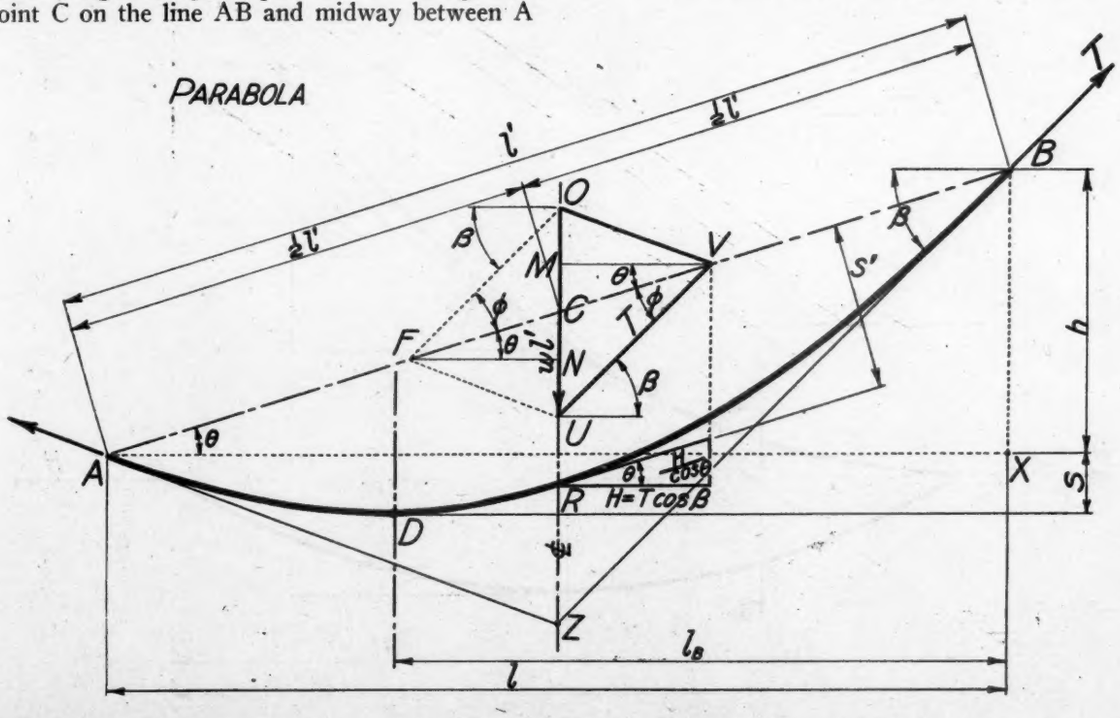


Fig. 8.

This is also the total tension in the wire at the point (if any) where the slope of the wire is zero. The total stress in the wire is greatest at the highest point B, and the vertical component of the reaction at this point is $UM = NO = T \sin \beta$.

The weight supported by the lower tower is $MO = wl^1 - T \sin \beta$.

In some cases this may be zero, or it may even be a negative quantity, in which case the wire will exert an upward pull on the lower support. In that case the sag S below the point A will be zero. This is not an unusual condition on a steep incline or on a moderate incline if the spans are short.

The position of the lowest point D in the span is determined by the condition that the vertical component of the force acting at either point of support is the weight of that part of the wire between the point D and the point of support. This is true because the tension in the wire, at the point D, has no vertical component. The horizontal distance of the point D from the support B is

$$l_b = l \times \frac{ON}{OU} = \frac{l \times T \sin \beta}{wl^1} = \frac{T \sin \beta \times \cos \theta}{w}$$

It may happen that l_b will be found to be equal to or greater than l, in which case the support A will be the lowest point in the span. If the vertical component of the force at the support B is greater than the total weight of the span (wl^1), it follows that the resultant force at the support A will be in an upward direction.

The total sag is $S + h$. The value of this sag may be determined by considering l_b to be one-half of a span having supports at the same level and having the sag,

$$S + h = \frac{w}{\cos \theta} \times \frac{(2 l_b)^2}{8 H} = \frac{w l_b^2}{2 H \cos \theta}.$$

Stringing Wires in Spans on Steep Grades.

When transmission lines are carried up steep grades and are strung on towers in such a manner that the lower support A is the lowest point of the span, it is of considerable advantage in stringing the wires to know the maximum deflection of the wire from the straight line AB as observed by sighting between the points A and B. Such a condition is shown in Fig. 9.

A line drawn tangent to the curve and parallel to the line AB will be tangent at the point R, which is on a vertical line drawn through the point C at the middle of the line AB. The wire will, therefore, have its maximum deflection from the line AB at this point R. The horizontal projections of AR and RB are equal and have the value $\frac{1}{2}l$ when the horizontal projection of the span AB is l.

Let the deflection of the wire, at the point R, from the straight line AB be denoted by S^1. By taking moments about the point A and putting their sum equal to zero, we may determine the value of this deflection.

$$\frac{H}{\cos \theta} \times S^1 = \frac{wl^1}{2} \times \frac{l}{4} \text{ or}$$

$$S^1 = \frac{wl^1}{2} \times \frac{l}{4} \times \frac{\cos \theta}{H} = \frac{wl^2}{8H}$$

Comparing this span with a span having the same horizontal projection but supports A and B^1 at the same level, it will be seen that when a wire is strung between supports on a slope, the maximum deflection S^1 of that wire from the straight line joining the two points of support

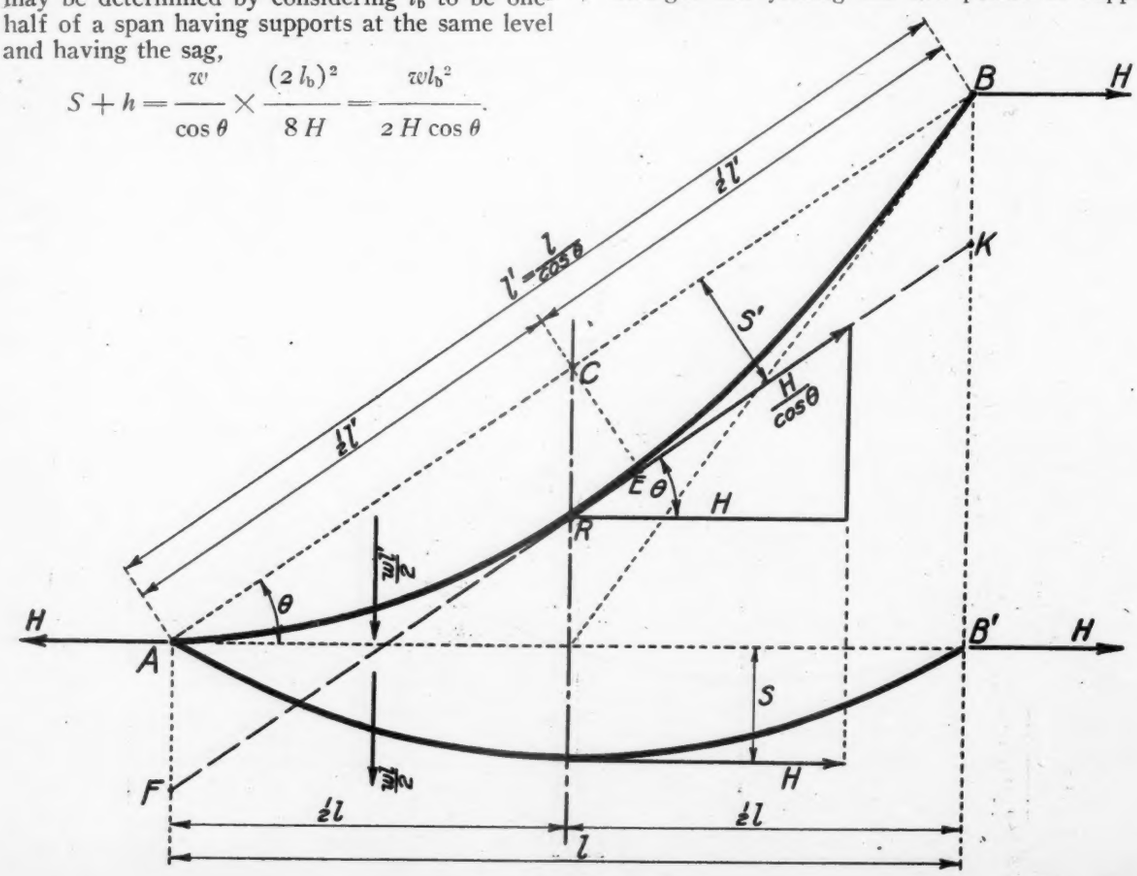


Fig. 9.

is exactly the same as the maximum sag S of the same wire when strung between points on the same level; provided the span measured horizontally and the horizontal component H of the tension are the same in both cases.

These formulas for lines carried up steep inclines are all based on the assumption that the total weight of wire is the weight per foot of length of wire multiplied by the length of the line AB (which is $l^1 = l/\cos\theta$). This, of course, is an approximation which is the more nearly correct as the sag is kept small in proportion to the span.

Having determined the value of S^1, and knowing the value of θ, we may determine the value of CR. This distance can then be measured down vertically below the points of support A and B, as shown at F and K, and the wire when strung between these two supports may be drawn up until it becomes tangent to the line FK parallel to AB and at the distance CR vertically below AB. This may be observed by sighting from F to K.

The length of the wire between fixed supports at the same horizontal level is, approximately, $L = l + 8S^2/3l$, in which l is the distance between supports and S the sag at the center, both expressed in feet. In the case of a wire between supports which are not on the same level, the total length may be considered to be made up of two distinct parts of the parabolic curve.

Relation Between Stress, Temperature and Sag.

All of the formulas so far deduced for determining working conditions for the wires on the basis of using parabolic curves have been obtained by ignoring the fact that the wires are elastic and will therefore stretch under tension and that the length will also be affected by changes in temperature.

It is customary to assume that the material of the conductors is perfectly elastic up to a certain critical stress, known as the elastic limit, and that the process of elongation and contraction follows a straight line law. Therefore, the length of the wire will be changed by the amount of elongation or contraction which will be $L_e = L \times T_e/E$, in which L_e is the elongation or contraction, L is the unstressed length of wire, T_e is the stress per square inch in the wire, and E is the modulus of elasticity.

The change in length due to differences of temperature will be $L_t = L_o\,(1 + mt)$, in which L_o is the original length, t is the number of degrees Fahrenheit change in temperature, and m is the coefficient of expansion for the material in the conductor. These two changes in length of wire are not independent of each other. They act simultaneously and are inter-related and must be considered together. Any temperature variation causes a change in the length of wire, which, in turn, changes the sag condition, and hence changes the stress which, in turn, will affect the amount of change in length of wire due to the stress in it.

In the case of long spans it is always necessary to make proper allowances for the changed outline of curve assumed by wires, due both to their elasticity and to the elongation or contraction resulting from changes in temperature. This is also advisable oftentimes in the case of comparatively short spans, especially where a minimum clearance is required under the lowest wires with the worst conditions of loading. This matter has been the subject of quite extensive investigation on the part of several different men, and several different solutions of the problem have been offered. No theoretically correct analytical solution that is easy of application has yet been found, but every one is based on assumptions which involve some approximations. The first assumption generally made is that the parabola approximates near enough to the true curve in which the wire hangs. For short spans this is not much in error, but on the longer spans the difference in results obtained by figuring the curve first as a parabola and then as a catenary is very considerable, especially when changes due to the elasticity of the wire and to differences in temperature are taken into account.

Some mathematical expressions have been worked out for taking care of these conditions approximately, but they all involve the first and third powers of the unknown quantity. It is a tedious matter to solve such equations, which is another reason why they are not satisfactory, especially when it is known in advance that the result, when obtained, will not be accurate.

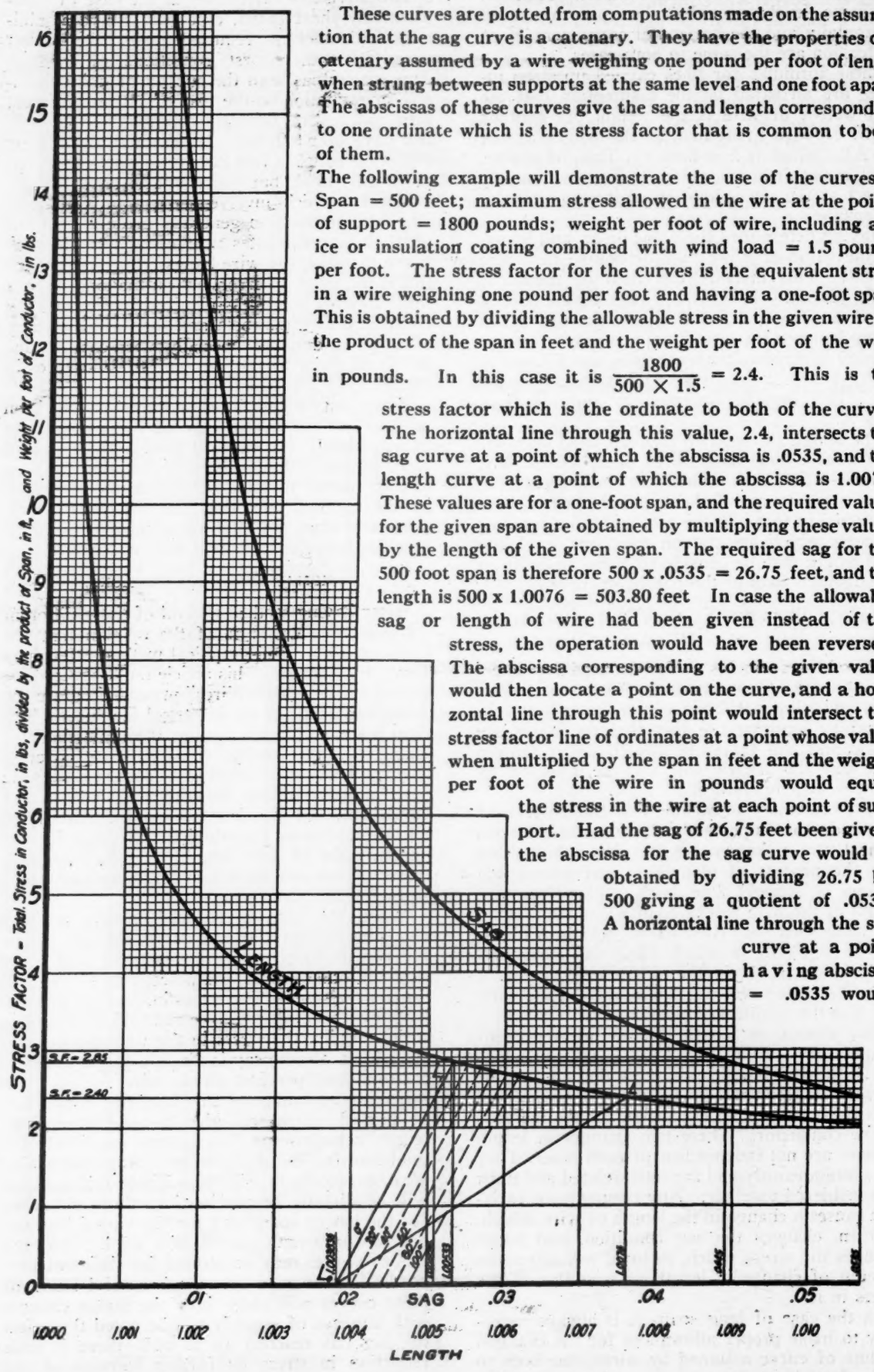
Thomas' Sag Calculations.

After having studied several of these different solutions, the writer is of the opinion that the best one is the semi-graphical method offered by Percy H. Thomas in his article on "Sag Calculations for Suspended Wires" presented before the American Institute of Electrical Engineers. The true catenary is used and, at the same time, all changes in the loading conditions are covered. A given problem is attacked by first reducing the span in size, without changing the shape of the curve, until the span is 1 ft. Having determined all the conditions attending the problem for the similar span of 1-ft. length, it is then an easy matter to convert these into corresponding quantities for the given span.

When the span is reduced in size without changing the shape of the curve, the sag will be reduced in direct proportion to the reduction of span; in other words, the percentage of sag will remain the same. The stress in the wire and the length of wire also will be reduced in the same ratio. Again, the stress in the wire for a given span for a definite sag is directly proportional to the total load per foot on the wire.

Taking advantage of this fact, two curves can be plotted which will give the sag, stress and length relationships for a wire on which the total load is 1 lb. per ft. when strung over a 1-ft. span, as shown in Fig. 10. These relationships will be directly proportional to those obtaining for the longer spans and for the varied loadings per foot of length on the wire used. Different sets of curves may be plotted for different proportions of sags to spans. A careful study of these curves will show how the stress changes with increase of sag. It will be noted that after the sag has reached 15 to 20% there is little reduction in stress by further increase of sag and that an actual increase of stress soon re-

THOMAS' CURVES FOR SAG AND



These curves are plotted from computations made on the assumption that the sag curve is a catenary. They have the properties of a catenary assumed by a wire weighing one pound per foot of length when strung between supports at the same level and one foot apart. The abscissas of these curves give the sag and length corresponding to one ordinate which is the stress factor that is common to both of them.

The following example will demonstrate the use of the curves. Span = 500 feet; maximum stress allowed in the wire at the points of support = 1800 pounds; weight per foot of wire, including any ice or insulation coating combined with wind load = 1.5 pounds per foot. The stress factor for the curves is the equivalent stress in a wire weighing one pound per foot and having a one-foot span. This is obtained by dividing the allowable stress in the given wire by the product of the span in feet and the weight per foot of the wire in pounds. In this case it is $\frac{1800}{500 \times 1.5} = 2.4$. This is the stress factor which is the ordinate to both of the curves. The horizontal line through this value, 2.4, intersects the sag curve at a point of which the abscissa is .0535, and the length curve at a point of which the abscissa is 1.0076. These values are for a one-foot span, and the required values for the given span are obtained by multiplying these values by the length of the given span. The required sag for the 500 foot span is therefore 500 x .0535 = 26.75 feet, and the length is 500 x 1.0076 = 503.80 feet In case the allowable sag or length of wire had been given instead of the stress, the operation would have been reversed. The abscissa corresponding to the given value would then locate a point on the curve, and a horizontal line through this point would intersect the stress factor line of ordinates at a point whose value when multiplied by the span in feet and the weight per foot of the wire in pounds would equal the stress in the wire at each point of support. Had the sag of 26.75 feet been given, the abscissa for the sag curve would be obtained by dividing 26.75 by 500 giving a quotient of .0535. A horizontal line through the sag curve at a point having abscissa = .0535 would

STRESS CALCULATIONS (FIG. 10)

intersect the stress factor line of ordinates at 2.4. This value when multiplied by the span in feet and the weight of the wire per foot in pounds would give the desired stress, thus;

$$2.4 \times 500 \times 1.5 = 1800$$

Variations in Loading

Assume the load to decrease from 1.5 to 0.5 lb. per ft., the temperature remaining the same. The resulting conditions of Stress, Sag and Length are determined as follows. If all the load could be removed from the wire it would contract to its "unstressed" length, called L_0, from its full-load length, L = 1.0076 ft. per foot of span. If the sectional area of the conductor = .03 sq. in.; the coefficient of elasticity = E = 16,000,000, and the total stress = 1800 lb., then,

$$L = 1.0076 = L_0 + \frac{\frac{1800}{.03}}{16{,}000{,}000} \times L_0,$$

from which,

$$L_0 = \frac{1.0076}{1 + \frac{\frac{1800}{.03}}{16{,}000{,}000}} = \frac{1.0076}{1.00375} = 1.003836 \text{ ft. for one-foot span.}$$

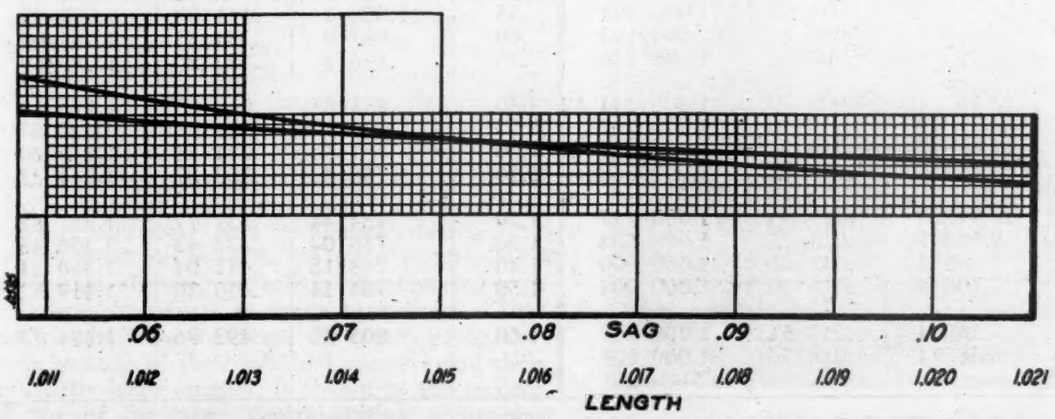
Plot this on the zero Stress Factor line, at L_0. Then the line L_0L is the "stress-stretch" line for this particular span and loading. If the load of 1.5 lb. per ft. stretches the wire for one-foot span from L_0 to L, a load of 0.5 lb. per ft. will stretch it $\frac{0.5}{1.5}(L - L_0) = \frac{1}{3}(1.0076 - 1.003836) = .001255$ ft., which, added to L_0, gives the length of the wire for the lighter load, 1.005091 ft. for one-foot span. Plot this value on the same Stress Factor line as for the preceding load, S. F. = 2.4, and through this point and L_0 draw a line to the Length curve. Its intersection, $L_1 = 1.00533$, is the length of the wire for one-foot span for a load of 0.5 lb. per ft. For this new condition the properties of the 500 ft. span will be: Stress = 500 x 2.85 x 0.5 = 713 lb.; Length = 500 x 1.00533 = 502.665 ft.; and Sag = 500 x .0445 = 22.25 ft. This operation is reversed when working from a light to a heavier load, the principle being the same in all cases.

Temperature Variation

The preceding methods assume a constant temperature, but every change of temperature causes a readjustment of Stress, Sag and Length in any span. To determine the new conditions, first find L_0, the "zero stress" length of wire for one-foot span, as above described. Then compute the change in this length resulting from the change of temperature, and plot this variation from L_0 along the zero Stress Factor line. This gives the "unstressed" length for the new temperature, and through this point draw a line parallel to the "stress-stretch" line for the load then existing. Its intersection with the Length curve gives the new length of wire for one-foot span, and determines the other factors. For example, if the above computation was for a temperature of 0° F., and the properties of the span are required for 20° intervals to 100° F., and the coefficient of heat expanison is .0000096, the length at 20° F. will be,

$$L_{20°} = L_0 (1 + .0000096\ t) = 1.003836 (1 + .0000096 \times 20) = 1.004029 \text{ ft.}$$

Through this new length draw a line parallel to line L_0L_1. It intersects the Length curve at 1.005505, the coincident values being: Stress Factor = 2.8, Sag = .0453. Then for the 500 ft. span, Stress = 500 × 2.80 × .5 = 700 lb., Length = 500 × 1.005505 = 502.7525 ft., Sag = 500 × .0453 = 22.65 ft. Similarly for successive 20° intervals, or for any other temperature changes.



VALUES USED FOR PLOTTING CURVES FOR WIRE WEIGHING ONE POUND PER FOOT OF LENGTH WHEN SUSPENDED IN ONE-FOOT SPAN

$$\text{Stress} = Y = \frac{C}{2}\left(e^{\frac{X}{C}} + e^{-\frac{X}{C}}\right)$$

$$\text{Sag} = Y - C$$

$$\text{Length} = 2 \times \frac{C}{2}\left(e^{\frac{X}{C}} - e^{-\frac{X}{C}}\right)$$

X/C	Stress	Sag	Length	X/C	Stress	Sag	Length
.0050	100.001 3	.001 250	1.000 004 2	.080	6.270 0	.020 01	1.001 066
.0055	90.910 5	.001 375	1.000 005 1	.085	5.903 6	.021 26	1.001 205
.0060	83.334 8	.001 500	1.000 006 1	.090	5.578 1	.022 52	1.001 351
.0065	76.924 7	.001 625	1.000 007 1	.095	5.286 9	.023 77	1.001 503
.0070	71.430 3	.001 750	1.000 008 2	.100	5.025 0	.025 02	1.001 668
.0075	66.668 5	.001 875	1.000 009 4	.105	4.788 2	.026 27	1.001 839
.0080	62.502 0	.002 000	1.000 010 7	.110	4.573 0	.027 53	1.002 017
.0085	58.825 7	.002 125	1.000 012 0	.115	4.376 6	.028 78	1.002 205
.0090	55.557 8	.002 250	1.000 013 5	.120	4.196 7	.030 04	1.002 402
.0095	52.633 9	.002 375	1.000 015 0	.125	4.031 3	.031 29	1.002 606
.010	50.002 5	.002 50	1.000 017	.130	3.878 7	.032 55	1.002 819
.011	45.457 3	.002 75	1.000 020	.135	3.734 2	.033 80	1.003 040
.012	41.669 7	.003 00	1.000 025	.140	3.606 5	.035 06	1.003 270
.0125	40.003 1	.003 13	1.000 026	.145	3.484 6	.036 31	1.003 508
.013	38.464 8	.003 25	1.000 028	.150	3.370 9	.037 57	1.003 754
.014	35.717 8	.003 50	1.000 033	.170	2.983 8	.042 60	1.004 825
.015	33.337 1	.003 75	1.000 037	.200	2.550 2	.050 17	1.006 680
.016	31.254 0	.004 00	1.000 043	.220	2.328 0	.055 22	1.008 086
.017	29.416 0	.004 25	1.000 048	.25	2.062 8	.062 83	1.010 444
.0175	28.575 8	.004 38	1.000 051	.27	1.919 8	.067 91	1.012 194
.018	27.782 3	.004 50	1.000 054	.30	1.742 2	.075 56	1.015 068
.019	26.320 5	.004 75	1.000 060	.32	1.643 2	.080 68	1.017 154
.020	25.005 0	.005 00	1.000 067	.35	1.517 0	.088 40	1.020 542
.022	22.732 8	.005 50	1.000 081	.37	1.444 9	.093 56	1.022 973
.024	20.839 3	.006 00	1.000 096	.40	1.351 3	.101 34	1.026 881
.025	20.006 3	.006 25	1.000 104	.42	1.297 0	.106 55	1.029 660
.026	19.237 3	.006 50	1.000 113	.45	1.225 5	.114 41	1.034 093
.028	17.864 1	.007 00	1.000 131	.47	1.183 5	.119 68	1.037 224
.030	16.674 2	.007 50	1.000 150	.50	1.127 6	.127 63	1.042 19
.032	15.633 0	.008 00	1.000 171	.55	1.050 1	.141 00	1.051 19
.034	14.714 4	.008 50	1.000 193	.60	.987 9	.154 55	1.061 09
.036	13.897 9	.009 00	1.000 216	.70	.896 5	.182 26	1.083 69
.038	13.167 4	.009 50	1.000 241	.80	.835 8	.210 83	1.110 13
.040	12.510 0	.010 00	1.000 267	.90	.796 2	.240 61	1.140 57
.043	11.638 7	.010 75	1.000 308	1.00	.771 54	.271 54	1.175 20
.047	10.650 1	.011 75	1.000 368	1.10	.758 42	.303 87	1.214 23
.050	10.012 5	.012 50	1.000 417	1.20	.754 44	.337 77	1.257 88
.055	9.104 7	.013 75	1.000 504	1.30	.758 04	.373 43	1.306 45
.060	8.348 3	.015 00	1.000 600	1.40	.768 18	.411 04	1.360 21
.065	7.708 4	.016 26	1.000 704	1.50	.784 14	.450 80	1.419 52
.070	7.160 4	.017 51	1.000 817	1.60	.805 46	.492 96	1.484 73
.075	6.685 4	.018 76	1.000 938				

sults. This is of extreme importance when considering the use of very light wires on long spans.

The sine of the angle made by the wire with the horizontal, at the point of support, is one-half the length of wire in the span divided by the stress with 1 lb. per ft. weight of wire and may be obtained from the length curve.

Considering the case of a span having supports at unequal heights above a given horizontal plane, if the horizontal distance from the higher support to the lowest point of the wire is known, the stress and sag in this part of the span can be determined by considering this part as one-half of a span equal to twice this distance. The smaller stress in the other part can be determined in the same manner.

The following formulas, based upon the catenary, give the horizontal distance from the higher support to the lowest point of the wire:

$$l_u = l/2 + hT/l - h^2/2l \quad \ldots\ldots\ldots\ldots (A)$$

$$= dl/h \times (1 - \sqrt{1 - h/d}$$

$$= l\sqrt{d}/(\sqrt{d} - h + \sqrt{d}) \quad \ldots\ldots\ldots (B)$$

where

l = the span in feet.

l_u = the horizontal distance in feet from the higher support to the lowest point of the wire.

h = the difference in height of the two supports in feet.

T = the stress in pounds in the wire at the higher support, with 1 lb. per ft. load on the conductor.

d = the sag in feet measured from the higher point of support.

Formula (A) is useful when the span and the stress to be allowed in the wire are given, and formula (B) when the span and the sag are given.

These formulas are approximate in that the horizontal projection of the wire is substituted for the actual length of it. Formula (A) is correct within from 2% to 4%, when neither sag nor difference in heights of supports exceeds 15% of the span. Formula (B) has an error of less than 1% under these conditions.

CAUSES OF ELECTRICAL FIRES.

The National Board of Fire Underwriters, which has been tabulating the causes of fires in the United States, investigated the electrical fires reported during a typical week recently and found that of 540 fires, 252 were caused by flatirons, 82 by defective cords and 206 by all other causes. The hazard of electric flatirons is that they are so frequently left standing with the current on. Misuse of properly installed electric cords by amateur electricians is also a cause of many fires. Of the 206 miscellaneous electrical fires tabulated during the typical week referred to, 76 were in attics and basements, showing the effects of tampering with the wires in efforts to make extensions. That electric flatirons constitute the principal hazard, both because of their inherent dangers and their unusually large number, is shown by the records of one of the large central-station companies which made a tabulation of the domestic devices in use by its customers. This showed that 88% of the customers had electric flatirons, 18% had toasters, 10% washing machines, 9% vacuum cleaners and 4% had percolators.

ONE-MAN STREET CARS EQUIPPED WITH SAFETY PANELS.

Special Panel Prevents Contact With Live Circuits and Reduces Attention Required.

The Brooklyn Rapid Transit Co., in their 200 one-man safety cars recently purchased from the J. G. Brill Co., Philadelphia, Pa., have adopted a new safety feature to protect the operator by the installation of Westinghouse-Krantz safety panels. These panels make it impossible for the operator to come in contact with live parts either while controlling the car or renewing fuses.

The panel is mounted above the vestibule window and, as shown by the illustration, is within easy reach of the operator. They are somewhat similar to panels used in subway cars and stations of the New York Municipal Railway Co.

The switches are all single-pole and with one exception are single-throw. The switch controlling the light-transfer circuit is double-throw to take care of the transfer of light from front to rear headlights. All of the switches are double-end, double-break, quick-break brush-type with brushes protected by arcing contacts at each end.

Each switch is mounted on a separate bakelite micarta panel, covering an individual compartment insulated from each adjacent compartment by means of molded asbestos composition barriers. These act as arcing shields to prevent the arc formed upon opening a switch from communicating with an adjacent circuit. Fuse connections are provided in compartments separate from those of the circuit switches. The cover or door over each fuse compartment is inter-

Safety Panel Used for Protection of One-Man Street Car Operator.

locked with the corresponding switch mechanism so that it can be opened only when the switch is in the off position and the fuse contacts dead. On account of the shortage of available space for mounting these panels, the outside dimensions have been reduced to a minimum, making the size of the complete panel 30.5 by 10 by 4.5 ins. The total net weight is 55 lbs.

ELECTRICALLY DRIVEN PUMP CUTS SAVANNAH'S WATER COST.

The city of Savannah, Ga., is now effecting a large saving due to the installation of motor-driven pump on an artesian well, furnishing 4,000,000 gallons of water daily to the city. The plant from which the city formerly got its water supply cost $65 a day to pump a million gallons of water, while the new equipment pumps at the rate of $10 a million gallons. If the city decides to install electric pumps throughout, and the indications are that it will do so shortly, a saving of $57,500 a year will be effected in fuel and labor.

The artesion well is 519 ft. deep, and was dug by the use of dynamite. A 24-in. casing was sunk to a depth of 110 ft., and from there to the bottom a 16-in. casing is used. The pump, which is of the Layne & Bowler centrifugal type, is installed 100 ft. below the surface. It is driven by a 200-hp., two-phase, 60-cycle, 2200-volt, 1175-r. p. m. vertical induction motor, which was built by the Westinghouse Electric & Manufacturing Co. Energy for the operation of the motor is supplied to the city by the Savannah Electric Co.

POWER PLANT AT EAST GADSDEN, ALA., BEING REHABILITATED.

Changes Made in Boiler-Room Equipment, Switchboard, Switching Equipment and Transmission Lines of Alabama Power Co. Plant.

Extensive improvements are being made to the Alabama Power Co.'s steam power plant at East Gadsden, Ala. This plant together with the Warrior River plant, 30 miles west of Birmingham, is operated in conjunction with the company's large hydroelectric plant at Lock 12 on the Coosa river, the former two being held in reserve in case of low water or other trouble at Lock 12. At the time of its construction in

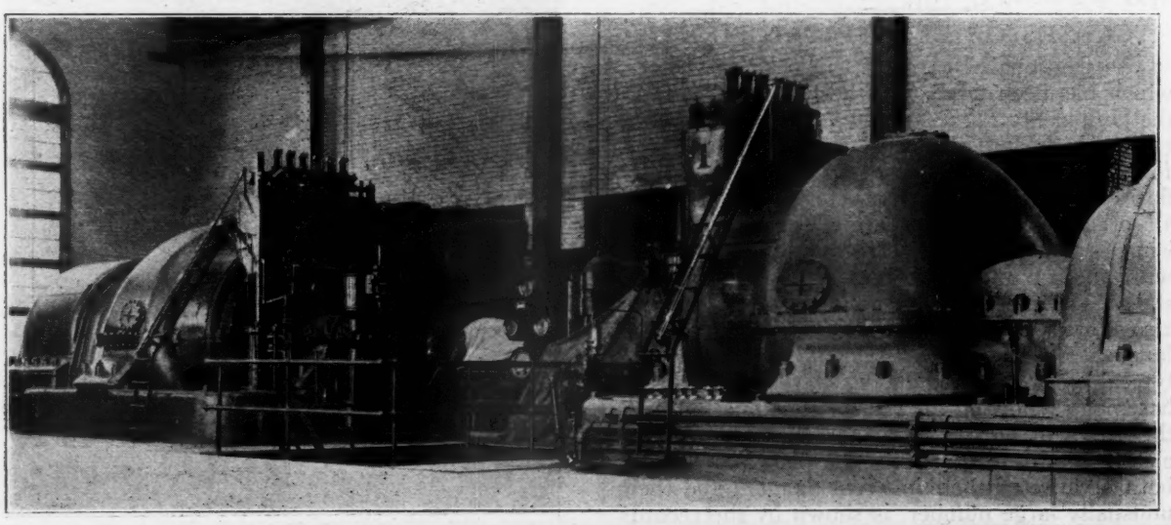
Construction Work in Installing Underfeed Stokers at East Gadsden Plant of Alabama Power Co.

1912-13 the East Gadsden plant, which cost approximately $1,500,000, was one of the most modern plants in the South.

In the boiler room there are six 600-hp. water-tube boilers equipped with stokers and baffles. The stokers had a capacity of about 90 tons of coal per 24-hour day and are being removed for replacement by underfeed, seven-retort stokers which will have a greater capacity.

The substation and switch structure are being remodeled and enlarged, the former to accommodate the new 110,000-volt line to Guntersville and Huntsville, Ala., which line will eventually be connected to the Sheffield generating plant. This latter plant is already connected to the Warrior River plant. This plan will give the company a power line covering a large part of northern Alabama.

In the generating room the switchboard will be removed from the end of the building and made to face the two 5000-kw. turbogenerators. These machines, which will not be changed in any way, generate at 2300 volts, which is stepped up to 22,000 for local distribution and to 110,000 volts for transmission to other parts of the company's territory in case of emergencies.



Two 5000-Kw. Turbogenerators in East Gadsden Plant of Alabama Power Co., Which is Undergoing Extensive Improvements.

EDITORIAL COMMENT

Training Electric Furnace Operators

It is seldom that an industry develops more rapidly than a personnel necessary to sustain it. The ordinary situation in any industry is that its development is tediously slow, so slow, in fact, that many men employed in it make only slight progress up the ladder of promotion in an entire lifetime. This is a condition that applies with particular significance to those men who exert their effort by hand instead of by head. At least one industry, however, has proved to be an exception to the general rule if the speakers at the meeting of the Electric Furnace Association held in Boston on April 9 represented the industry correctly. The unanimity of opinion expressed by the relatively large number of speakers and their varied experience in and close touch with that industry is convincing proof of the correctness of their remarks. Their testimony was to the effect that the use of electric furnaces is being restricted by a shortage of men trained in operating them.

To remedy this unusual situation is a task that should be undertaken soon. All that is needed is a workable scheme for training operators. The great difficulty, however, is in deciding on the nature of the training and the kind of men to be trained. Opinion is not unanimous upon these. Certain speakers suggested letting the engineering colleges do the training, others suggested letting the manufacturers of furnaces do it individually, and others suggested letting the Electric Furnace Association supervise the training. Some speakers suggested training technically trained men and others suggested using men without the college training. Evidently each suggestion has its merits and demerits. One wonders how the colleges can crowd much more into their curricula than they have there already. Moreover, since a furnace operator cannot be trained on the small equipment that the colleges possess, the value of their training would be problematical. Colleges can scarcely afford to install and operate equipment of the large capacities now in common use.

The problem seems to be one for the manufacturers and users of furnaces to settle, since experience shows that skill in the operation of furnaces comes only from actual practice in operation during a considerable interval of time. In addition, because furnaces are of different types and are extremely individualistic, training given on one furnace may not teach a man to operate another. Even a trained operator who has taken a short vacation finds difficulty on his return to work in operating satisfactorily a furnace with which he was previously perfectly familiar.

Quick thinking and intelligent acting upon the occurrence of eventualities are such necessary qualifications for furnace operators as to make it seem desirable to train men with as much technical knowledge as possible. A scheme whereby owners of furnaces will arrange apprenticeship courses suggests itself as being practical. Cincinnati University reports this scheme to be successful in other industries. No reason exists to doubt its practicability in the electric furnace industry. Whether college trained or other men will prove to be most desirable operators is a matter for time to determine. For the present the task is to work out a scheme of training that will relieve the present unusual situation.

Education in the Boiler Room

The increasing price and scarcity of fuel is serving to bring forward the importance of training for the men engaged in the daily routine operations of the boiler room. The careful operating practice followed by skilled operators in boiler testing is often considered a waste of effort by the regular boiler-room attendants. This lack of appreciation for the fine points of operation is due in part to failure of the men to understand the connection between good practice and economy, and in part to their lack of instruction in good operating practice.

The economies in both fuel and labor that can be accomplished by substituting careful operation for the shiftless practices often found will total figures that are well worth consideration.

Many central-station managers have long realized the importance of trained workers in the power plant and have conducted schools and classes for the education of the men. An illustration of this practice is given by the recent announcement that the Milwaukee (Wis.) Electric Railway & Light Co. has recently adopted a course of training, involving co-operation with the University of Wisconsin through its Extension Division. The course, which will be taken

by 40 selected employes of the company, will cover "boiler room practice" and will require half a day a week for a period of 12 weeks.

This plan should work out to the good of both the men and the company. It should also serve to call the attention of other managers to the possibilities of training as a means of reducing costs, of improving operating reliability, and, in general, of increasing the efficiency of their organizations.

Segregating Industries Using Hydroelectrical Energy

The suggestion by John L. Harper in his paper presented on April 9 at the joint session of the meetings of the Institute of Electrical Engineers and Electrochemical Society held at Boston that industries utilizing water power should be segregated was timely. In the opinion of Mr. Harper, the water-power resources of the country should be classified into four divisions according to the possibility or desirability of pondage for conserving runoff. The four divisions mentioned consist of those projects of which fluctuating flow may be developed without pondage, those of which the flow may be developed with some pondage, those of which pondage is possible, and those of which no pondage is possible. When this classification is made and the power resources are developed, according to Mr. Harper, the industries permitted to use the energy should be segregated so that those needing continuous energy at full capacity may be located near projects capable of producing such a supply, and industries requiring intermittent energy may be located near appropriate projects.

The preceding suggestion is one that should receive close attention even before the enactment of the water-power legislation now pending before Congress. Perhaps it would be unwise to endeavor to incorporate the idea in the compromise bill that is hoped for if its incorporation will cause any delay in enactment. The principal desideratum now is to get enabling legislation that will permit the development of water-power resources. That will provide a means for conserving some of the natural energy of the streams that is now being wasted. The most nearly complete conservation of this natural resource, however, after the power sites are developed will be possible if the energy is apportioned wisely.

How this apportionment should be made is a matter for careful study. To allow industries of every kind to make indiscriminate use of the energy developed would be to practice anything but conservation. Certain industries can operate only if they receive a continuous supply of energy uninterruptedly. Others can accommodate their operations to varying supplies of energy such as might be occasioned by seasonable variations in stream flow. Some must depend upon hydroelectrical energy, whereas others can operate successfully upon hydroelectrical energy when it is available and steam power at other times. The whole matter of use of hydroelectrical energy is related so closely to that of its production that the former cannot be neglected if conservation of natural resources is to be practiced. The suggestion, which comes at an opportune time, contains a thought worth considering.

Foreign Trade

Figures furnished by the United States Bureau of Foreign and Domestic Commerce show a slight falling off in the average of electrical goods exported during January and manufacturers say that incoming orders from the foreign trade have shown a decrease since November. Export shipments have held close to the record rate established last fall, but they are beginning to reflect the slight slump in bookings.

This decrease is by no means regarded as a lasting condition. Japan is considered a big prospective purchaser, and it is believed that large orders for manufacturing and water-power equipment will be received from that country during the spring and summer. The impossibility of obtaining a sufficient supply of coal is forcing Japan to an immediate development of her unused water power. Practically all of this equipment will be purchased in the United States.

Very little equipment is being exported to Europe, due to the fact that the larger electrical companies have an important interest in almost all of the European electrical plants. Execution of any of the numerous plans for the electrification of European railways would mean some large orders for the leading American companies, but none of these plans has so far been completed. Italy plans eventually to electrify 6000 kilometers of railway and a dozen or more projects are said to be under consideration in France.

Orders received from South America compare favorably with the high rate reached last fall. Improvement in the industrial situation in Buenos Aires is expected to be reflected in an immediate increase in bookings.

The conclusions to be drawn from this information are that electrical exports will soon be on the increase, with the possibility of approaching figures never before attained.

CURRENT EVENTS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

PENNSYLVANIA ASSOCIATION HOLDS SUCCESSFUL MEETING.

Eastern Section Hears Papers by P. H. Bartlett, H. B. Vincent and P. L. Miles at Well-Attended Philadelphia Sessions.

The first meeting of the Eastern Section of the Pennsylvania Electrical Association was held at Philadelphia, Pa., March 25, with 35 central-station companies represented at the sessions, at which the following papers were read and discussed: "Grounding Secondaries," by P. H. Bartlett, Philadelphia Electric Co.; "Customers' Appliance Repairs," by H. B. Vincent, Day & Zimmerman, Philadelphia, and "Electric Cooking," by P. L. Miles, Edison Electric Appliance Co., Chicago.

Mr. Bartlett's paper brought out the advantage of grounding to water pipes where possible. The fact was also brought out that while the first cost and maintenance of ground wires, while not necessarily a determining factor, is one that must receive serious consideration. In Mr. Bartlett's opinion the grounding of an existing system must be borne by the company, but that the expense of grounding on new services, which is primarily for the customer's protection, should be borne by the customers.

At the luncheon, which was attended by many members of the Electric Club of Philadelphia, in addition to the 100 central-station representatives at the meeting, talks were given by J. B. McCall, president of the Philadelphia Electric Co.; W. C. L. Eglin, chief engineer of the same company and a past president of the N. E. L. A.; Henry Harris, vice-president of the Pennsylvania Electric Association; E. D. Dreyfus, chairman of the Pennsylvania Geographic Sections Committee, and M. E. Arnold, president of the Electric Club.

MANY SIDE TRIPS PLANNED FOR N. E. L. A. CONVENTION VISITORS.

Entertainment Committee Has Arranged Interesting Program of Short Excursions to Southern California Points.

To make it possible for the delegates who visit the convention of the National Electric Light Association at Pasadena, Cal., May 18-21, to see every feature of Southern California life within the shortest space of time, with the greatest possible convenience, and by special arrangements such as are not obtainable by the individual tourist, is the aim of W. L. Frost, chairman of the Entertainment Committee.

Among the plans that he has already completed is a trip to Santa Catalina island, 26 miles from the mainland, which is the mecca of pleasure seekers and fishermen the world over.

One of the most interesting of the trips which Mr. Frost has arranged is through "Filmland," or the motion-picture studios, some 60 of which are located within easy ride of Hotel Huntington, the convention headquarters. The delegates will be shown through the studios and be permitted to see the actual stage work, and to learn the part that electricity is taking in the art of motion-picture photography.

There will be trips to all of the famous beach resorts which extend for miles along the Pacific coast, and trips by trolley and automobile through what is known as the "Orange Empire." In this "Kingdom of the Citrus," the groves will be in full bearing at the time of the convention, and the cultivation, picking and packing of the fruit will be a novelty to those who have never before had an opportunity to study it.

Mount Lowe, which stands a mile high on the summit of the Sierra Madre range, is another beautiful trip easily taken from Hotel Huntington. It is reached by a cable railroad and a daring piece of electrical trolley construction, which carries the visitor within a short ride of the summit.

COAL AND LUBRICANTS DISCUSSED BY STATE ENGINEERS.

Important Items of Power Plant Operation Are Covered by Talks and Practical Demonstrations at Illinois University Meeting.

Papers and discussion on the purchase, testing and economic use of coal and lubricants held the attention of chief engineers of Illinois state institutions in their second annual convention, held April 9-10, at the University of Illinois.

A lecture on "Methods of Boiler Testing" by A. P. Kratz of the university brought out a number of common mistakes made in boiler testing and presented proper methods to use. Stress was laid on the importance of weighing coal and feed water. A special point was made of the necessity of keeping time records of everything done and of recording data in the form of a "graphical log." It was pointed out that serious errors might result from leaky valves or from failure to record charges of coal or water.

"Coal and Its Production" was presented in an illustrated talk by S. H. Viall of the Chicago, Wilmington & Franklin Coal Co. Shaft, drift and strip mining were explained and illustrated with moving pictures and slides. Mining machines, mine railways, blasting, coal screening, washing and shipping were all illustrated and described. A definite point was made of the statement that the domestic classes of fuels were

the ones that gave the most profit to the producer. In the discussion on coal washing it was brought out that in one mine all 3-in. or smaller coal goes through the washer with the result that its ash content is reduced from 27 to about 8%. The discussion developed the fact that high ash percentages in fine coal are, in the main, due to shale droppings from the mine roof and also to fire clay picked up with the lower layers of the floor.

Prof. S. W. Parr gave a short talk on coal sampling and methods of analysis. The relative merits of hand and machine preparation of the sample were gone into and data showing the great uniformity of machine sampling was presented. The data showed less than ½% variation in ash content of various parts of the machine prepared sample. Following Prof. Parr's talk, a demonstration of coal sampling and sample preparation was given in the basement of the boiler room. Samples were prepared by hand and by the use of a Sturtevant automatic sample grinder. The party visited the chemistry building where the ultimate reduction of a coal sample was demonstrated. A sample was weighed, dried, reweighed, ground to dust fineness, divided and redivided, all with great care. Portions of the sample were tested for sulphur, ash and B.t.u. The outstanding feature of this demonstration was the care and precision that is used in the process of coal analysis.

Lubricants Save Power.

A. H. Prichard of the Vacuum Oil Co. gave a practical talk on "Lubricating Oils," going into the production of lubricating oils from crude petroleum, and covering in brief the methods of manufacture, by-products, and quality of lubricants. The talk featured the practical difficulty of selecting or judging the quality of lubricating oils by specification or by standard tests. Practical operating tests over a long period of time were recommended as the only means of properly selecting lubricants. A lantern slide, reproducing a chart for selecting cylinder oil, illustrated the various factors involved in oil selection, and also the various oils prepared by the Vacuum Oil Co. to meet the combinations of factors or conditions. The talk brought out the point that bearing oil or engine oil was not yet as well standardized for use as cylinder oil and that extensive tests were still required to make selections for specific cases. Economy of power was given as the object of lubrication, and it was pointed out that the possible economy of power in many cases is much greater than the entire cost of all lubricants used. The waste or needless use of oil was condemned not only as a waste of money, but also as a waste of a valuable commodity needed by others.

Paper on Safe Electric Wiring.

F. J. McCullough presented a paper on "Safe Electric Wiring." This paper covered the development of the National Electrical Code and the various city codes and illustrated points wherein these codes were suitable or unsuitable for use in public institutions. Recommendations were made for the best type of construction in order to reduce as far as possible both fire and personal injury hazards. The idea was emphasized that institution patients in many cases are far from normal, and so require special precautions to be taken in wiring installations so they may be safeguarded.

The party was conducted through the university power plant by Joe Morrow, who pointed out and explained the coal crusher arrangement, laid out to feed into a continuous bucket conveyor which handled drippings and ashes as well as coal, the automatic coal scales installed over each stoker, the V-notch feed water meter, the water purifying plant and other points of boiler-room practice.

The general discussion, led by Fred J. Postel, covered the special problems of heating, plumbing, lighting, wiring and ventilation, as they apply to institution work. Dr. Eugene Cohn of Kankakee, Ill., discussed features of hydrotherapeutic equipment.

TELLS OF GENERAL ELECTRIC'S WORK IN WIRELESS FIELD.

C. A. Coffin Discusses Alliance With Marconi Company and of Research Work That Has Aided Radio Industry.

In his annual report to the stockholders of the General Electric Co., C. A. Coffin, chairman of the board of directors, calls attention to the work the company has been doing in recent years in the development of wireless telegraphy. Mr. Coffin says:

"The company has for several years been engaged in its research laboratories and factories in the development and manufacture of devices essential to the transmission and reception of wireless communications. Its inventions have had a far-reaching effect on the entire radio art. The Marconi Wireless Telegraph Co. of America is also the owner of valuable patents, rights and licenses, and it has been deemed wise to the boards of directors of both companies that their research and engineering resources should hereafter be used in the closest co-operation. To this end, and in order to secure the benefits of the long and varied electrical manufacturing experience of the General Electric Co. on one hand and the operating experience of the Marconi company on the other, a new company has been formed, known as the Radio Corp. of America, in which both the General Electric and Marconi companies have accepted a considerable participation."

Chairman Coffin also called attention to the organization of the International General Electric Co., Inc., formed for the purpose of taking over assets, investments and activities of the General Electric Co. in foreign countries, covering manufacturing, selling, engineering, utility enterprises, etc. In forming the foreign company the General Electric subscribed for all its stock, consisting of $10,000,000 7% preferred stock at par and $10,000,000 common stock at 110, paying therefore $21,000,000 cash (part before Dec. 21, 1919, and the balance in January, 1920), and sold to the International General Electric Co., Inc., securities and accounts of a like value.

Symposiums Feature Boston Convention of the American Electrochemical Society

Industrial Applications, Electrically Produced Alloys, Electric Furnaces and Power for Electrochemical Purposes Are Chief Topics of Discussion

The thirty-seventh general meeting of the American Electrochemical Society was held in Boston April 7-10, at which an unusual program of papers and entertainment was provided. Besides other features, the members and guests were privileged to attend joint and parallel sessions of the American Electric Furnace Association and the American Institute of Electrical Engineers. The meetings were held in various places to provide an opportunity to inspect both the old and new buildings of the Massachusetts Institute of Technology.

Registration began April 7 at the Copley-Plaza Hotel, followed by a meeting of the board of directors. The open sessions began April 8, the program at the first session consisting of the annual business meeting, the report of the board of directors, the announcement of the names of new officers elected, reports of committees, the presidential address, and a symposium on colloid chemistry. The presidential address, delivered by the retiring president, Prof. Wilder D. Bancroft, of Cornell University, was on "Contact Catalysis."

Papers were read at the first session on colloid chemistry and electrochemistry, on settling and sedimentation problems, on graphitic acid, graphitic carbon determination, selective absorption of B. Pyocyaenus, on the effect of alternating current on hydrogen overvoltage, hydrogen ion concentration in dry cells, the reactions of the lead accumulator, and on arc images in chemical analysis.

Applications of Chemistry to Industry.

Papers presented at the afternoon session related to chemical problems met in the industries, dealing with the production of cyanide, carbon determination in iron, carbon in iron, influence of inclosed slag on the corrosion of wrought iron, the embrittling effects of pickling iron, the electrolytic production of calcium, electrolytic chromium, bronze plating, and physical characteristics of refractories.

W. S. Landis, in describing a new cyanide, stated that the electrochemist had triumphed over foreign competitors by developing a new method of producing cyanide from cyanamid. With the use of a small, continuous-type electric furnace they were producing the equivalent of 4 tons of sodium cyanide per day at the end of three months after beginning plans for the plant. The product is of better quality than any produced in Germany.

The papers by C. J. Rottman and T. D. Yensen on carbon determination in iron were of importance since they are first to establish a method of making an accurate determination. The method will have the effect of reducing the tolerance of the carbon limits in many specifications where an accurate knowledge of the amount of carbon present is desirable. The determination of carbon in iron is 100 times more delicate than any other known method.

After the close of the afternoon session the members were conducted through the laboratories of the institute. This inspection trip was followed by an evening spent at the Arthur D. Little, Inc., laboratories in Cambridge.

Symposium on Electrically Produced Alloys.

H. E. Howe, representing the Alloys Research Association work of the National Research Council, read the first paper at the Friday session, which was held jointly with the American Institute of Electrical Engineers. This paper was followed by one on recent developments in the ferro-alloy industry prepared by R. J. Anderson, who discussed conditions in the industry during the last five years and the present status of the electric furnace production of alloys. He said that the electric furnace has made the growth of the industry possible.

The importance of the electric furnace in the steel and other alloy industries was mentioned by several other speakers. Its great advantages over other kinds of furnaces are numerous. Some of them are the high temperatures possible, the freedom from contamination of the product, the ease and certainty with which the product can be controlled, the absence of volatilization of certain alloy elements, and the rapidity with which action takes place in the furnace. The last named advantage is one of extreme importance, as was indicated by B. D. Saklatwalla in his paper on ferro-vanadium. Because vanadium is in great demand, considerable study has been given to its production. This production by the wet process was extremely laborious and slow. When it was finally produced by the dry process, it was found to behave different from any other element. It showed many valencies and properties varying with the reduction of oxides from acid to alkaline. A sudden application of heat and rise in temperature that causes a sudden reduction of the ore, however, eliminates the change of properties. In the aluminum reduction process in the electric furnace, the action is quick and takes place at high temperatures.

The value of the electric furnace in preventing volatilization of readily volatile elements in alloys was indicated by the paper by Elwood Hawnes on "Stellite" and its subsequent discussion. The alloy, which is composed of cobalt and chromium without the presence of iron, is non-forgeable and extremely hard. It finds a ready use in high-speed cutting tools and cutlery. It has been declared to be ideal for use in surgical instruments and was used very largely in those instruments purchased by the medical departments of the allied armies during the war. The particular advantages of cutting instruments made from it is that they do not

tarnish or corrode when kept immersed in cleaning solutions and the edges remain keen after long usage. But the difficulty in producing the alloy is that the cobalt volatilizes so rapidly in the blast furnace that the alloy cannot be produced commercially. This difficulty is eliminated in the electric furnace.

Another instance in which the electric furnace has entirely replaced the blast furnace is in certain processes in the production or armor plate in England. It has been necessary to scrap something like 50% of certain kinds of armor plate in the English mills because of imperfections. When this scrap was remelted in the blast furnaces the cobalt was entirely removed. It was found that to do the remelting in the electric furnaces retained the cobalt in the melt so that it could be poured and used again for armor plate.

As a means of producing tool steel, the electric furnace has no competitor, according to Ray C. McKenna, a manufacturer of high-speed steel. The reasons for the superiority of the electric over the blast furnace are many. Mr. McKenna mentioned particularly the ease with which the melt can be controlled. When a charge is placed in the furnace, one who uses ordinary care in manipulation can foretell with considerable certainty what will come out of it. The experience of tool manufacturers is that the best tools have been produced from the electric furnace. One important feature about the operation of any furnace is the fact that it will not turn out a satisfactory product if proper materials are not included in the charge. Some of the operating figures mentioned were that a 3-ton melt utilized 1000 kw-hrs. The average lining lasted through 80 heats.

The matter of size of electric furnaces in the iron and steel industry was mentioned by some of the speakers. C. B. Gibson, in his paper describing the manufacture of ferro-alloys in the electric furnace, stated that the limiting sizes have not yet been definitely established. He mentioned 10,000 hp. as the limit for a commercial furnace on a 60-cycle line and 22,000 hp. on a 25-cycle line. Just which frequency will eventually prove to be most satisfactory is undecided. F. A. Raven, in his paper, stated that he knows of no particular reason for claiming one frequency to be superior to another. E. S. Bardwell stated that the frequency employed for the furnaces at the mines in Butte is 60 cycles, and that the power-factor is about 80%. The receiving voltage is 110,000, which is stepped down to 6600.

Others who presented papers were R. M. Major, Alcan Hirsch, C. F. Harding, T. D. Yensen, Matthew A. Hunter and J. W. Bacon. Among those who discussed the papers were W. D. Bancroft, Colin G. Fink, E. O. Benjamin, J. W. Richards, F. C. Frary, G. L. Norris, F. S. Weiser, F. W. Brooke, C. A. Winder, H. W. Gillett, Arthur R. Bullock and L. S. Finch.

Friday afternoon inspection was made of the General Electric Co.'s plant at Lynn, and this was followed by the informal dinner of the Institute.

The Friday evening session, at which Calvert Townley, president of A. I. E. E., presided, was arranged to bring out the relation between power and the electrochemical industry. Several phases of the relationship were presented, among which were the effects of electric furnaces on central-station loads, the use of water power in the industries, suiting industries to the kind of power available, water-power resources, and the principles and details of electric furnaces.

Symposium on Power for Electrochemical Purposes.

Papers by H. L. Hess and E. A. Wilcox described the relations between the central-station companies and electric furnace operators. Mr. Hess presented a brief history of the development of the electric furnace and experience gained in its operation. The first furnaces were designed, from necessity, on the theoretical considerations only. Data are sufficient now so that furnaces can be designed to fit conditions. Installations should be made to suit the size of the source of energy. The most satisfactory product is drawn from furnaces of which the capacities are not more than 8 or 10 tons.

The relation between central-station companies and furnace operators could be more satisfactory than it is. Central-station operators might find it advantageous to regulate rates for furnace operators more to the satisfaction of the latter than they are doing at present. The matter of regulating the operation of the furnaces on schedules so that the power demand would exist at off-peak periods does not seem feasible in general.

The paper by Mr. Wilcox contained matter relating to the rates that may be established by central-station companies for electric furnace operators, the relative amounts of load that may be taken from lines, to peaks and ways of avoiding them, to power-factors and to other conditions. Rates are established in various ways. Where they are unfavorable if the energy is taken during peak-load intervals, they can be made attractive if the energy is taken at off-peak intervals. This arrangement is feasible and is in existence in certain localities. Furnace operators can co-operate in getting favorable rates established by arranging their operations to follow definite schedules. This arrangement is particularly easy for those operators who are making large castings because the casting process takes much less time than preparing the molds. There is no reason why casting cannot be done at night.

It is desirable to operate furnaces at capacity because the energy consumed does not increase in proportion to the material produced. It is usually found that the more rapid the melting the more satisfactory the product and the less the heat losses. The cost per ton of product is less the more rapid the process; consequently, the source of energy should be large enough to accommodate large drafts.

The paper by W. G. Berlin, in which he discussed the requirements for energy during the melting process and compared the operation of large and small furnaces, raised the question of the relative advantages to be gained by operating a large furnace slowly or a small furnace rap-

idly. The discussion brought out the fact that the greater advantage accrues from operating a small furnace rapidly than from the other plan. The disadvantages mentioned included the tendency to hasten the process to such extent that an undesirable product results and the sudden and extreme demand put upon the supply lines. The product derived from the two methods of furnace operation is satisfactory if proper precautions are taken.

Electric furnace equipment was described by John A. Seede and H. A. Winne, the former exhibiting several slides showing the general design of the different furnaces now in use, including those with fixed and movable electrodes and induction furnaces. Mr. Winne described reactors for electric furnaces. He classified them into iron-core reactors, air-core reactors, and reactors cast in concrete. His judgment is that the latter are the most desirable.

A third group of four papers presented various aspects of natural energy resources. John L. Harper stated that the ideal power development would strike a balance between the production of energy by means of coal and by waterfalls. In some instances and for some purposes energy from steam plants is preferable. In other circumstances hydroelectric energy is preferable. Water-power projects may be separated into four classifications and the industries dependent upon them for energy should be regulated accordingly. These classes are (1) that in which the run-off does not require pondage; (2) that in which some pondage is necessary to distribute the run-off; (3) that in which pondage is possible, and (4) that in which no pondage is possible. Energy from classes 1, 2 and 3 should be devoted to intermittent use, and from 4 to continuous use. Naturally, since classes 1, 2 and 3 would need to be supplemented with steam power, the kind of industries supplied by those classes of streams should be those for which interruption of energy supply would not be detrimental and in which chances for economies may exist. The kind of industries ideal for class 4 is that which takes a steady supply without fluctuations, such as the electrochemical industries. As a matter of fact, the power from continuous-flow sites should be reserved for the electrochemical processes.

The principal source of hydroelectric energy is on the Pacific Coast. But the backwardness of the development has created an actual power shortage there at present. Although California has 3,500,000 hp. available water power, it will have ready for use in 1921 only 800,000 kv-a. The hydroelectric energy per capita in the three Pacific Coast states is only 0.2 hp., whereas in Norway it is 0.5 hp. The 500,000-hp. development at The Dalles on the Columbia river is not practicable now because there are not available sufficient industries to use the energy developed. One reason for the lack of development was mentioned by Calvert Townley. This is the fact that no legislation exists to make hydroelectric development safe as an investment proposition. Enabling legislation recently passed both houses of Congress and the two bills are now being considered by a joint committee of the two houses.

The papers on hydroelectric development were prepared by F. F. Fowler, C. T. Maynard and J. W. Beckman. Those who took part in the discussions include H. S. Webster, J. W. Richards, F. Hudson, Carl Hering and others.

Electric Furnace Session.

The Saturday morning meeting was held in the new lecture hall of Harvard University. The program was arranged so that the papers would emphasize features of the electric furnace that had not been mentioned at the previous meetings. Some of these features are the practicability of continuous-feed, self-baking electrodes, producing synthetic pig iron by means of the electric furnace, step induction regulators to control the voltages, suitability of the various classes of electric furnaces to the production of brass, the position of the electric furnace in the steel industry, and the theoretical considerations involved in the reduction of manganiferous silicate slags. A paper of unusual interest suggesting a method of preventing disturbances to central stations by the operation of electric furnaces was presented by Alexander C. Smith.

Self-baking electrodes made and fed continuously already are being manufactured by C. W. Söderburg, of Christiania, Norway. A set of three 32-in. electrodes, which is now being installed at Anniston, Ala., will be placed in operation within the next few weeks. Tests of this type of electrode show that it is in practically every way as desirable as the pre-cast electrodes and the cost only about one-half as much as the latter. The tendency of nearly all machinery is toward automatic and continuous operation. This tendency is observed in electric furnace development, as is indicated by the use of the continuous-feed electrode and the step induction regulator to control voltage variations.

That the electric furnace has a definite place in the metal industry is agreed. There is considerable disagreement or variation of opinions about defining its absolute place. Perhaps an effort now to assign its place is, after all, premature, since its development in the steel industry is compassed almost within a decade and in the brass industry within two years. The census of furnaces recently made indicates that about 300 electric furnaces are in operation in the steel industry at present and about an equal number in the brass industry. Opinions vary from those predicting a general use of electric furnaces to those predicting a very limited use. The eventual utility of the furnace will be, in the steel industry at least, somewhere between these two diverse views. Its likely adoption will be, as Prof. Joseph W. Richards suggested, by those industries and concerns that want to make a high-grade product in which contamination is not permissible, in which the atmosphere will be reducing if anything, in which pure heat only will be applied to the bath, and in the production of which it is desirable to subject the bath to high temperatures for considerable intervals of time. This means that the electric furnace will not supplant the present methods of recovering iron and steel from the ores or of producing ordinary steel in large quantities.

In the brass industry there seems to be a place

for all of the electric furnaces on the market. But before a furnace is installed in a plant a careful investigation should be made so that the proper furnace can be selected. Installing a furnace blindly is an invitation for trouble. Whether a furnace melts a ton of brass with 160 or 500 kw-hrs. is relatively unimportant. Volatilization of alloy, size of melt, breakage of electrodes and absence of segregation of the melt are the matters of importance.

Those who presented papers include J. W. Richards, C. A. Keller, P. B. Short, J. West, H. M. St. John, L. B. Lindemuth, E. F. Kern and Alexander C. Smith. Those who took part in the discussions included Elmer R. Coe, J. D. Noyes, S. A. Tucker, T. W. Richards, F. W. Brooke, George M. Berry, Carl Hering, F. S. Weiser, H. W. Gillett, G. A. Winder and others.

Upon invitation of the Huff Electrostatic Separator Company, the members were privileged to visit the company's plant at Arlington on Saturday afternoon.

Officers elected for the ensuing year are: W. S. Landis, president; John A. Matthews, A. T. Hinckley and L. E. Saunders, vice-presidents; Colin G. Fink, Acheson Smith, and H. B. Coho, managers; Joseph W. Richards, secretary; and P. G. Salom, treasurer.

ELECTRIC FURNACE ASSOCIATION MEETS IN BOSTON.

Progress of Electric Furnace and Necessity for Trained Operators Brought Out at Meeting of Association.

The importance of the electric furnace industry was emphasized at the meetings of the Electric Furnace Association held in Boston April 7. That the electric furnace is rapidly winning a place in industry was brought out at the meeting. The kernel of the remarks of those who spoke was that the principal difficulty in operating furnaces at present lies in finding men competent to operate them.

Acheson Smith, the president of the association, read the principal paper at the meeting. He presented statistics to show the rapidity with which the electric furnace is being introduced. In 1913 only 30,180 gross tons of steel ingots were produced by electric furnaces. In 1918 the amount had increased to more than 500,000 tons. In the production of alloy steel also, the electric furnace is a factor. The figures for 1918 are 287,885 gross tons of ingots and 66,485 tons of castings. Although a large number of electric furnaces were installed during the interval of hostilities, statistics show that all have been operating since at a considerable percentage of capacity. Moreover, during 1919, at least 33 new electric furnaces were sold for the production of steel, and at least 88 for the production of brass.

The furnace situation is unsatisfactory only for the reason that such furnaces are being installed more rapidly than operators are being trained to control them. In every other respect the situation is satisfactory. At the beginning of 1919 approximately 58 electric furnaces were producing brass. Only one year later the number had increased to 146. Because the superiority of electrically melted brass and steel has only recently been appreciated, manufacturers of machinery requiring special properties are wasting no time in installing these furnaces. The automobile manufacturers alone are creating a good market for them in their desire to produce metal parts having special properties. In addition to the production of castings, heat treating is creating an unlimited field for electric devices.

Necessity for Training Electric Furnace Operators.

The problem now for manufacturers and users of electric furnaces to solve is the best method of training operators. The need for them is acute and time is required for their training. Two methods are possible by which the training can be supplied. One is for universities to undertake it. The other is for the industries or for the Electric Furnace Association to do so.

The general agreement with Mr. Smith of men in the electric furnace industry was shown by the unanimity of opinion of the large number who discussed his paper. Both of the methods of training furnace operators suggested by Mr. Smith had advocates. Dr. Joseph W. Richards, of Lehigh University, said that the schools are doing their best already to train these men. He stated that teachers recognize two classes of students, namely, mature men with experience in trade, and immature, inexperienced youths. The former are less active mentally but more steady than the latter. They are economically equal after they have been out of school for five years. He recommends taking young men from the high school into the mills having electric furnaces, letting them serve not more than two-year apprenticeships and returning them to school.

Dr. F. A. J. Fitzgerald advocated apprenticeships after college training. Dr. O. R. Sweeney, of the University of Cincinnati, and Prof. Christianson, University of Minnesota, described apprenticeship courses that those institutions require now for graduation. Prof. W. H. Walker, Massachusetts Institute of Technology, advocated training during the four-year college course and special training by the manufacturers. The schools should confine their work to fundamentals. H. C. Cooper, of the College of the City of New York, emphasized the impossibility of teaching students the operation of large furnaces because of inadequate equipment.

L. J. Pritz, of the Timken Roller Bearing Co., believes that a college degree should be given only after a two-year apprenticeship has been served. His opinion is based on his experience in employing college trained men and men not so trained. He thinks that the latter make better furnace operators because they are willing to do the arduous, physical work necessary in a mill and are more readily subject to discipline. Trained men are scarce.

L. B. Lindemuth said that the operator of an electric furnace should have technical training and must be imaginative so that he can meet intelligently and quickly the emergencies that the electric furnace presents.

Colin G. Fink suggested that manufacturers

employ apprentices and give them time to attend school. He differentiates between the superintendent and foreman in a mill. Others who spoke included E. T. Moore, Holcomb Steel Co.; H. G. Weidenthal, James H. Herron Co.; F. J. Ryan, American Metallurgical Corporation; W. E. Moore, Pittsburgh Furnace Co.; C. H. Booth, Electric Furnace Co.; R. L. Baldwin, Republic Carbon Co.; and Mr. Brooks, Electric Furnace Construction Co., Philadelphia.

The time and place of the next meeting was fixed tentatively for September in New York City.

The following officers were elected: President, Acheson Smith; vice-presidents, C. H. Booth and H. L. Hess; secretary, C. G. Schluederberg; treasurer, F. J. Ryan; directors for two years, F. J. Tone and H. G. Weidenthal.

UNIVERSITY OF ILLINOIS SHOW IS BIG SUCCESS.

Over 6500 persons attended the seventh biennial electrical show given by the students at the University of Illinois, Champaign, Ill., April 8-10, under the auspices of the Electrical Engineering Society, a student organization. Two floors of the electrical laboratory and the entire gymnasium annex were devoted to the activities of the show. In all there were 69 separate exhibits and demonstrations distributed throughout the two buildings.

Among the exhibits was a demonstration of gun pointing patterned after the Ward-Leonard system. In this exhibit a miniature gun throwing a wood projectile, by electric power, was mounted on a boat-shaped platform which was rocked by means of a motor drive to imitate the rolling motion of a ship at sea. Motors mounted on the platform rotated the gun in all directions.

Other exhibits included demonstrations of signal corps equipment, electric furnaces, pyrometers, manual and automatic telephone equipment, color effects in lighting, electric welding, high-voltage and high-frequency current and a miniature monorail car.

ROCHESTER ENGINEERS TO DISCUSS INDUSTRIAL HEATING.

The April meeting of the Rochester Section, American Institute of Electrical Engineers on April 23 will be devoted to the reading and discussion of a paper on "Industrial Electric Heating as Applied to Medium and Low Temperature Processes," by Wirt S. Scott, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

ORVILLE WRIGHT TO RECEIVE JOHN FRITZ MEDAL.

"For achievement in the development of the aeroplane" Orville Wright will be presented with the John Fritz medal by the board of award, composed of representatives of the national societies of electrical, mining and civil engineers, at the Engineering Societies building, New York City, May 7. The principal speakers on the occasion will be Maj.-Gen. George O. Squier, chief signal officer of the War Department, and Col. Edward A. Deeds, Dayton, O. The presentation speech will be made by Ambrose Swasey. The medal has been awarded in earlier years to Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas A. Edison, Charles T. Porter, Alfred Nobel, Sir William Henry White, Robert Woolston Hunt, John E. Sweet, James Douglas, Elihu Thomson, Henry Marion Howe, J. Waldo Smith and George W. Goethals.

A. I. E. E. TO HOLD ANNUAL MEETING, MAY 21.

The annual business meeting of the American Institute of Electrical Engineers will be held at the Engineering Societies building, New York City, May 21, at which time the report of the board of directors will be presented and the tellers' committee will announce the names of officers elected for the coming year. The Edison medal will be presented to William LeRoy Emmet. President Calvert Townley has named the following committee to make arrangements for the annual convention of the institute at White Sulphur Springs, W. Va., June 29-July 2: John H. Finney, chairman; Walter A. Hall, F. L. Hutchinson, Farley Osgood, Charles Robbins, A. M. Schoen and W. I. Slichter.

COMING CONVENTIONS.

Arkansas Utilities Association. Annual convention, Hot Springs, Ark., April 26-28. Headquarters, Arlington Hotel. W. J. Tharp, secretary, Little Rock, Ark.

Electric Power Club. Annual convention, Chattanooga, Tenn., May 5-8. Headquarters, Signal Mountain Hotel. C. H. Roth, secretary, 1416 West Adams street, Chicago, Ill.

American Association of Engineers. Annual convention, St. Louis, Mo., May 10 and 11. Headquarters, Planters Hotel. Secretary, C. E. Drayer, 63 East Adams street, Chicago.

Electrical Supply Jobbers' Association. Twelfth annual convention, Del Monte, Cal., May 12-14. Franklin Overbaugh, general secretary, 411 South Clinton street, Chicago, Ill.

Southwestern Electrical and Gas Association. Annual convention, Galveston, Tex., May 13-15. Headquarters, Hotel Galvez.

National Electric Light Association. Annual convention, Pasadena, Cal., May 18-21. Headquarters, Hotel Huntington. Acting secretary, S. A. Sewell, 29 West 29th street, New York City.

Missouri Association of Public Utilities. Fourteenth annual convention, Jefferson City, Mo., June 3-5. Secretary, F. D. Beardslee, St. Louis, Mo.

American Institute of Electrical Engineers. Annual convention, White Sulphur Springs, W. Va., June 29-July 2. Headquarters, The Greenbrier. F. L. Hutchinson, secretary, 33 West 39th street, New York City.

Ohio Electric Light Association. Annual convention, Cedar Point, Ohio, July 13-16. Secretary, D. L. Caskill, Greenville, Ohio.

Pacific Coast Section, American Institute of Electrical Engineers. Annual convention, Portland, Ore., July 21-23.

National Association of Electrical Contractors and Dealers. Annual convention, Baltimore, Md., Oct. 6. Secretary, W. H. Morton, 110 West 40th street, New York City.

COMMERCIAL PRACTICE

New-Business Methods, Policies, Rates and Kindred Central-Station Matters for the Man Engaged in Selling Electricity

PUBLIC SERVICE CO. OF ILLINOIS STOCK SALE A SUCCESS.

Over 17,000 Shares of Preferred Stock, Three-Quarters of Total Allotment, Has Been Sold by Employes of Company.

Over 17,000 shares of preferred stock of the Public Service Co. of Northern Illinois has been sold recently in the territory in which the company operates through a sales campaign in which the employes of the company constitute the sales force. This number of shares is three-quarters of the entire amount allotted for the campaign.

More than 7000 new stockholders have been created, including in the number members of all professions, trades and vocations in the various communities. The farmers are very strongly represented in the list of buyers.

"This new interest in the ownership of the Public Service company," says the *Public Service Lumen* in its April issue, "thoroughly represents the high intelligence of the many communities in the company's territory. The soundness of the security offered them and a desire on their part to be closely associated with a local enterprise, such as the company is in every community, strongly appeals to these investors."

Substantial commissions have been earned by many of the employes. The daily bulletins issued have told all about that and likewise the special chances to increase their commissions which have been extended. Also the bulletins are relating instances of buyers of the stock being found among people who are in almost daily contact with the company but who had not been invited to become purchasers of the stock. The 7000 new stockholders represent only a small percentage of the whole number of the company's customers. If purchasers are confined to these alone the security is presented in a potential market, where many thousands of people are provided with considerable knowledge of the property it represents.

CENTRAL-STATION APPLIANCE SALES SHOW GOOD VOLUME.

Sales of electrical appliances by central-station companies operating in and around Chicago continue in a very satisfactory manner, recent reports show. The volume is heaviest in the larger towns, but all parts of the territory are contributing to results which are much in excess of those gained in the same period of 1919. The most marked demand is for the labor-saving appliances, washing machines, vacuum cleaners and irons, but the sales include a wide variety of articles.

The commercial sales department of one big company operating in this territory has planned a series of campaigns extending through the year. Each month certain appliances will be taken up and pushed to the front in such fashion as to make them what is termed in general trade circles "leaders." There will, of course, be no neglect of other articles, but it is reasoned that by presenting one or two devices at a seasonable time results which usually proceed from strong concentrated effort can be obtained. The electric range will be the object of the April campaign of this company.

SAFETY COUNCIL ISSUES BULLETIN ON ELECTRIC SHOCK AID.

The National Safety Council, 168 North Michigan avenue, Chicago, has issued a large wall bulletin suitable for putting on the walls of power houses and central-station buildings giving the rules adopted by the National Electric Light Association for using the prone pressure method of resuscitation for electric shock. The bulletin is illustrated with three cuts showing the application of the treatment. The council has also issued pamphlet No. 29, entitled "Electrical Equipment in Industrial Plants," which, according to a subtitle, is "an orderly presentation in loose-leaf form of accident hazards and the best practices for their elimination." Copies of both the wall bulletin and the pamphlet can be obtained from the council.

MICHIGAN UTILITY COMMISSIONER DISCUSSES CAPITAL PROBLEM.

Unless there is sufficient reward in the way of dividends for public service corporations they cannot be expected to maintain or renew their plants, William M. Smith, chairman of the Public Utilities Commission of Michigan, told members of the Commercial Club, Saginaw, Mich., in a speech in which he pointed out the necessity for a fair rate of interest on public service investments, if the public's interests are to be protected.

"There is nothing mysterious about the problems of these concerns whose business it is to furnish power, light, heat, transportation and telephone service," said the Michigan state official. "Their expenses, like the expenses of every other corporation and of all private individuals, have gone skylarking since 1914. It is quite out of the question to expect that they can continue to sell their product or their service at the old rates and maintain the needed renewals and new installations.

"How many pounds of sugar would a grocer sell nowadays at 6 cents a pound? How many yards of calico would a merchant sell at 4 cents per yard? How many hours of labor would an automobile builder work on a basis of 30

cents an hour? How many tons of coal would a fuel dealer sell at pre-war prices?

"We have got to pay what the service rendered is worth if the public utilities are placed in a position to keep pace with the demands of growing communities. We must have more power, more light, more and better telephone service, more street car service, more gas manufacturing capacity. These demands all require enormous expenditures of capital. We cannot expect men to invest their money in such enterprises unless there is a fair prospect of satisfactory dividends. If this is not granted, the needed money will be diverted into other businesses and every community will suffer. Narrow-minded dealing and a limited vision at such a time might seriously hamper and retard the industrial development of the whole state."

PACIFIC STATES COMPANY TELLS OF CO-OPERATIVE SPIRIT.

"The Spirit of Co-operation" was the theme of an advertisement recently used by the Pacific Coast Gas & Electric Co. in several newspapers in its territory, and the idea is one that suggests itself to other central-station companies. Quotations from the advertisement follow:

"Emulation of nature is the best illustration of 'The Spirit of Co-operation.'

"Man sows the seed; it rains; the sun shines; the earth gives up her blessings which mankind harvests.

"No man attains success, or even progress, except by the aid of his fellow men. There is no such thing as an individual succeeding solely by its own efforts.

"The power company plows the grounds and sows the seeds of success for the entire industry. The manufacturer, the wholesale distributor, contractor and dealer promote a spirit of fertile good-will; the public reaps the harvest.

"The electrical field is destined to develop and grow in the minds of the people only in such proportion as is fostered by each branch of the industry."

MISSOURI COMISSION RULES IN COMPETITION CASE.

A ruling of more than passing interest to central-station companies was made recently by the Missouri Public Service Commission in the case of the Union Electric Light & Power Co., St. Louis, Mo., against the Libbe Power Co., of Washington, Mo. The Union company charged that the Libbe company was generating and selling electricity at Washington without having secured the consent of the state commission.

The commission on investigation found that the Libbe company generates and sells electricity to its own and other factories. For the company it was testified that it had not offered electricity for sale to the public at Washington and had not procured a certificate of convenience and necessity as provided under the Missouri public service commission law.

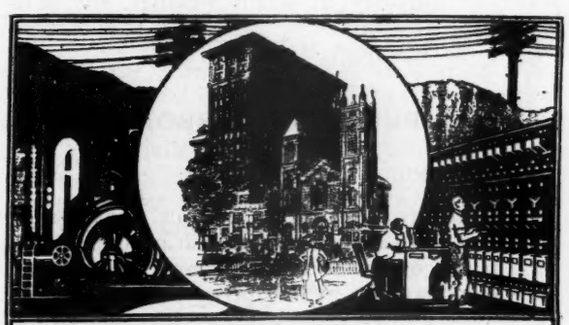
The Union company contended that it has the right to be protected against the operations of the Libbe company which interfere, or has a tendency to interfere, with its business, unless the Libbe company obtains the same rights from the Public Service Commission that the Union company has.

In the hearing it developed that there was no complaint against the activities of the Libbe company until it undertook to string its wires across a public street at Washington serve another factory. The Union company claimed that if the Libbe company was thus permitted to string wires to serve concerns other than itself it became subject to regulation by the public utility commission.

The commission in disposing of the case was guided by rulings in the Missouri Supreme Court and in the United States Supreme Court in which it was construed that the words "public use" in the governing law as meaning that the power of regulation was necessarily based upon the devotion of the property to public use. The commission ruling was to the effect that the Libbe company was not engaged in generating and selling electricity to the public and that it, therefore, was not an electrical corporation within the meaning of the public service commission law.

CENTRAL STATION AIDS PUBLICITY FOR ELECTRICAL SHOW.

A good example of co-operation between a central-station company and other electrical interests was shown in the recent Cleveland Electrical Show, given under the auspices of the Cleveland Electrical League, when in several newspapers before the opening of the show the Illuminating Company of Cleveland ran full-page advertisements in the daily newspapers urging attendance at the show.



Everyone in Cleveland Should See the Electrical Show

A visit to Cleveland's 1920 Electrical Show will prove well worth while for every citizen of Cleveland.

It will reveal in what countless ways electricity contributes to the convenience and comfort of our daily life—how much we all owe to the electrical industry for their untiring efforts in enslaving this wonderful force for the service of mankind.

Every branch of the electrical industry will be represented at Cleveland's Electrical Show. Everything electrical—from tiny pocket lamps to large furnaces—will be on exhibition; hundreds of time and labor-saving appliances for the factory, office and home. The exhibitors include the leading manufacturers of electrical products in the country—from Massachusetts to California.

You will find a visit to The Electrical Show both interesting and instructive. DON'T MISS IT!

The Illuminating Company
Illuminating Building
Public Square

Full-Page Advertisement Placed in Newspapers by Illuminating Co. of Cleveland, Urging Citizens to Visit the Electrical Show.

OPERATING PRACTICE

Methods and Problems Embracing Operation and Installation of Power-Plant Equipment and the Distribution of Electrical Energy

WASHED AIR COOLS GENERATORS AND INCREASES CAPACITY.

A modern 10,000-kw. generator requires about 2,500,000 cu. ft. of air an hour to keep it cool. Some of the grit and dust contained in this air deposits on the windings, forming a heat insulation which may cause overheating and short life of insulation. When carbon or steel dust is present the hazard is increased.

Freeing a generator of this accumulation of dirt is an expensive operation, requiring that the machines be dismantled. The frequency of such cleaning can be reduced by the use of suitable air cleaning equipment. For a power plant an air washer should be of superior design, as compared to an ordinary ventilation washer. Builders who have specialized in washers for generator service have so improved their equipment that it is possible to secure air washers which will operate with little attention and take a considerable portion of dirt out of the incoming air.

By cooling this incoming air to near the wet-bulb temperature air washers give additional generator capacity in warm weather, the safe load being determined by the rise in temperature within the windings.

LOW-TEMPERATURE CARBONIZATION OF COAL.

It is reported by the American Chamber of Commerce in London that British producers and industrial consumers of coal are showing an increasing interest in the theory and practice of low-temperature carbonization and its application to industry.

H. L. Armstrong, of the Institute of British Electrical Engineers, has recently written an exhaustive paper on this subject, claiming many advantages for the system, chief among which are the high value for domestic purposes of the fuel that is left after carbonization, and the uses to which the by-products could be put, especially oil and sulphate of ammonia.

Quantities of good bituminous coal are being burned needlessly in Britain today, a portion of which, it is claimed, could be turned into oil and a portion into a smokeless fuel as good as coal. It is even stated that if Britain were to carbonize one-third of her total coal production, the country would be absolutely independent of imported fuels. The savings that could be affected are apparent.

The claim is made that steam can be generated as cheaply by gas as it can by the use of raw coal. The low-temperature system is said to encroach in no way upon high-temperature coke, and the supply of non-coking coal in Great Britain is five times as great as coking—a point of considerable importance. Moreover, by the low-temperature process, a suitable fuel for burning in the grate can be obtained, as well as two or three gallons of benzol per ton of coal carbonized.

POND ELEVATION CONVERTED INTO KW-HRS. BY CURVES.

Rochester Gas & Electric Co. Works Out System to Indicate Power Available According to Elevation of Storage Pond.

By NORMAN H. DAVIDSON.

The ready conversion, by means of curves, of storage-pond elevations into kw-hr. capacity at the switchboard has been worked out for the pond at Station 5 of the Rochester (N. Y.) Gas & Electric Co. The method is practical and can be applied at any station where such ready conversion is desirable. The curves when once worked out will show at a glance the capacity remaining in the pond for various rates of power output from the generators.

In order to construct No. 1 curve shown in Fig. 1, a survey of the entire pond was made and the total volume of water was calculated for the various elevations within the working limits of 371 ft. and 391 ft. The set of curves shown in Fig. 2 was then drawn up to show the kw-hr. values of the water in the pond when used at different rates in the turbines at Station 5. The water-rate curves of the turbines give the data required to convert cu. ft. of water into kw-hrs. at the different generator outputs. In calculating these curves certain assumptions of conditions were made in order to simplify calculations and to make the curves of practical operating value. The actual head under which the turbines operate is continually varying, due to changes in the level of the water in the pond and tail race and also to tunnel and numerous other losses.

These variations introduce so many factors affecting the efficiency of the wheels and, therefore, the power value of each cubic foot of water, that a constant head was assumed for simplicity. This assumption does not introduce serious error where the total head is high and the variation small.

In calculating the curves a minimum bottom was assumed for the pond at the lowest level to which the pond should be drawn. From the pond capacity curve (Fig. 1) the kw-hr. value of the water in the pond above this bottom was determined for different loads on the generators. This value is different at different loads for the same amount of water because of the variable efficiency of the wheels.

These pondage curves, in addition to giving the amount of available pondage, may be used

to determine the stream flow expresssed in kw., as shown by the following illustration. At the beginning of a given hour period the water level in the pond was 387 ft. 6 ins. and at the end of the hour the level was 388 ft. 4 ins. During this

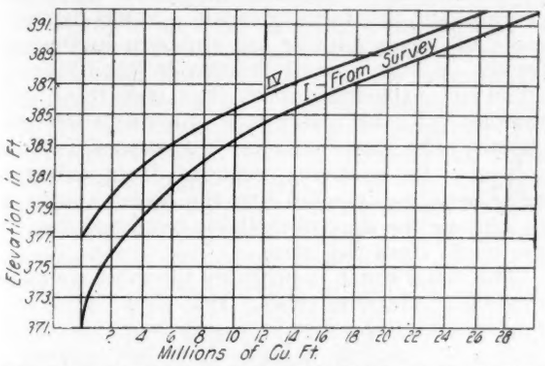


Fig. 1.—Pond Capacity in Millions of Cu. Ft. for Various Elevations.

hour the load on each turbine was 9000 kw., giving an output of 18,000 kw-hrs. From the curve (Fig. 2) marked "9000" it is seen that at the beginning of the hour there were 29,500 kw-hrs. available in the pond, corresponding to elevation of 387 ft. 6 ins., and at the end of the hour there were 34,300 kw-hrs. available, corresponding to elevation 388 ft. 4 ins. The difference, or 4800 kw-hrs., represents capacity actually gained during the hour. A total of 18,000 kw-hrs. were drawn from the pond during the hour so that the stream flow, or input to the pond, was 18,000 plus 4800, or 22,800 kw.

In determining the load curve to use in calculating the stream flow, the kw-hr. output for the period is used instead of the instantaneous load reading because it gives the average load for that period without further computation. When computing the flow for half-hour periods the kw-hr. output is doubled to obtain the load at which the unit is operating. This is necessary because the efficiency varies at different loads,

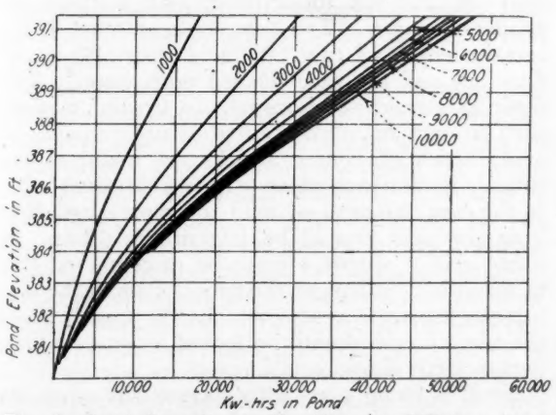


Fig. 2.—Pond Capacity in Kw-Hrs. for Different Pond Elevations and Generator Outputs.

changing the kw-hrs. which may be generated by each cubic foot of water.

The pondage curves originally worked up were found, after a time, to be very much in error. After considerable study it developed that a large part of the error was due to a partial filling up of the pond. Large quantities of the mud and rubbish carried down by the river were deposited by the slack water of the pond, reducing the storage capacity materially. After consideration of the probable amount of this deposit and an analysis of the operating data of several days, a new pond capacity curve was drawn as shown in No. 4, Fig. 1. From this, new pondage curves were calculated as shown in Fig. 2. These new curves are probably slightly in error but produce results of practical operating value. A complete survey of the pond would make it possible to correct the curves and at the same time locate the mud deposits. However, by keeping a careful record of outputs and pond elevations it is possible to change the original curves from time to time and keep them useful without resurveys except at long intervals.

ADDITIONAL OIL DUCTS TO REDUCE TEMPERATURE OF TRANSFORMERS.

High temperature in a number of 11,000/4150-volt, 60-cycle transformers was successfully overcome in the stations of the Rochester (N. Y.) Gas & Electric Co. in an interesting manner.

These transformers, though operated at rated capacity, have developed abnormally high temperatures due partly to insufficient oil duct capacity through the laminated iron and partly to the fact that iron instead of copper or brass coils are used to circulate the cooling water.

In order to eliminate this trouble, it was found necessary to disconnect and dissemble the transformers. The laminated iron was all removed and additional slots cut in the sections located between the different phases, thus forming when rebuilt extra oil ducts at the points most needed. The iron cooling coils were flushed with a solution of muriatic acid which entirely removed the scale and sediment. The transformers in which these changes and repairs have been completed are showing satisfactory operation.

HALTS BLAMING OF MYSTERIOUS FIRES ON ELECTRICAL CAUSES.

The Dayton (O.) Power & Light Co. has been doing a work recently that should commend itself to all in the electrical industry. The Dayton company, in co-operation with the officials of the Dayton fire department, investigate all fires of mysterious origin in that city and as a result the practice of blaming all fires of such origin on electrical causes has been almost eliminated. The following statistics showing the causes of fire in Dayton during 1919 indicate that out of a total of 1032 fires only nine were chargeable to defective wiring and there was a total of only 52 electrical fires. The fires in Dayton were charged to the following causes: Chimneys, 456; coal stoves, 19; coal furnaces and boilers, 53; electric, 52; gas, 67, gasoline, 8; gasoline automobiles, 39; gasoline automobiles in garages, 19; oils, 7; miscellaneous, 312. The electrical fires were divided as follows: Defective wiring, inside, 9; defective wiring for motors, 7; defective wiring for street cars, 8; defective aerial wiring, 24; electric ironing exposures, 4.

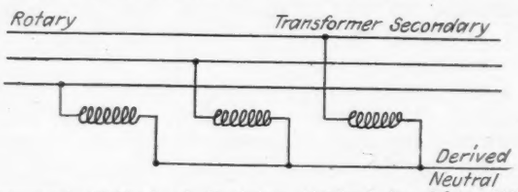
QUESTIONS AND ANSWERS

All readers are invited to submit questions and answers to this department. Anonymous communications will not be considered. Questions should relate to electrical matters of any kind. Answers contributed by readers should be submitted preferably within eight days of the date of publication of the question and should be limited, if possible, to 300 words. Payment will be made for all answers published.

Questions.

No. 475.—Pricing Motor Repair Work.—Can some of the readers through the questions and answers column give me the best methods of pricing repair work on electric motors, armature winding, etc., and the best methods of setting the selling price of insulating materials and of magnet wire?—D. D., Indianapolis, Ind.

No. 486.—Reactance to Obtain Derived Neutral.—The company I work for has a compound rotary converter rated at 300 kw., 250 volts, 1200 amperes, d-c.; three-phase, 60 cycles; and a 158-volt, 80-ampere, three-phase, 60-cycle reactance. As it is desirable to have a



Proposed Method of Deriving Neutral for Three-Wire Circuit.

three-wire d-c. system instead of a two-wire system, could this reactance be used in obtaining a derived neutral as illustrated? Would it take the place of the regular reactance between a rotary and its transformers?—L. S. K., Hammond, Ind.

Answers.

No. 482.—Cleaning Power-House Condensers.—What routine methods are usually employed for cleaning condenser tubes? We find that the dirt in our tubes changes at different times of the year, sometimes causing a hard brittle scale, at other times forming a slimy mass, like vaseline. How can this condition be overcome? What methods of cleaning are usually used?—J. M., McN., Tacoma, Wash.

Answer.—The precipitate that is thrown on condenser tubes may be roughly divided into two classes, namely, mud or slime and scale. Into the first class falls matter of a slimy soft nature, into the second class comes scale and sediment that adheres with considerable tenacity, whereas the grease-like slimy precipitate is like vaseline, removed merely by wiping.

The method of removing condenser tube precipitate depends upon the form the precipitate assumes. The frequency with which it is necessary to clean tubes also depends upon the form of deposit and its magnitude, since the reason for cleaning tubes is invariably to increase the heat transfer per square foot of tube surface. How often tubes should be cleaned depends upon the location of the condenser and the source of water supply. The frequency of cleaning often varies with the seasons; for example, power plants located on the Ohio river and similar rivers subject to wide water-level variation suffer during floods from foreign matter being carried into the condenser that has gotten past the screens; in the summer time the water level is low and contamination from industry and sewage again causes trouble. The only way to tell when the condenser tubes need cleaning is to determine the rate of heat transfer per square foot of condenser surface for a given water velocity (of quantity of water flowing through the condenser).

The method of cleaning condenser tubes depends upon the form of scale. Some deposits come off easily; others are stubborn in the extreme. Where a scale refuses to capitulate to attack by experimentation, it is well to submit samples of the precipitate to an analytical chemist who can then offer suggestions as to a solvent. In removing deposits from tubes it must be borne in mind that the object sought is to remove the deposit without removing any of the metal from the tubes.

The metal brush is probably the most common method of cleaning tubes. It is slow, there is a tendency to skip tubes here and there, and being such a tedious job, it tends to be left undone, a condition made more likely in that the condenser will require to be out of service a long time. Another method is to use compressed air in connection with a wad, which is shot through the tubes. One way of doing this which came in for considerable publicity a few years ago consisted of making up a number of pieces of canvass from canvass belting, each piece being slightly larger than the condenser tube. Through the middle of each wad a 3-in. nail was driven its full length. These wads were then inserted into the tubes, one per tube, at one end of the condenser and compressed air then applied to each tube at a time. The wads were shot through the tubes, taking grease and slime with them. At the other end of the tubes a man was stationed, whose work it was to collect the wads for use again. Both the above methods, when used in connection with water for flushing out the tubes, are applicable to tubes covered with soft and vaseline-like precipitate.

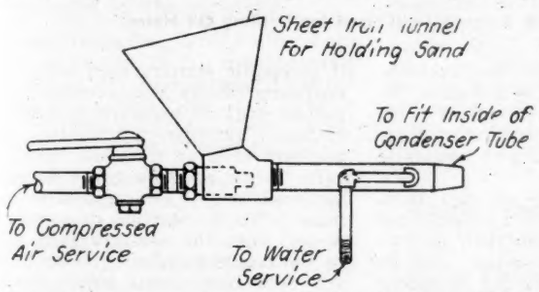
For scale of a hard dense nature, such as adheres to the surface of the tubes with considerable tenacity, muriatic or hydrochloric acid is sometimes employed. The tubes are plugged at one end and the tubes filled with acid of the proper strength. The tube is kept filled for a certain length of time, the acid then allowed to flow out and the tube flushed with water. The flushing should be thorough, to break off scale only in part removed, and to assure removal of acid, which of course attacks the metal of the tubes. Experience alone will indicate just what is the best strength of acid to employ and how long the acid should be left in the tubes. In using acid it should always be remembered that to do so is to endanger the tubes. While the acid attacks the scale it also attacks the metal, hence the use of acid should be looked upon as a desperate method and a last resort.

Sand is being used with success for removing every form of scale, but especially where the scale is hard in form and adheres with tenacity to the surface of the tubes. The objection to its use is the same as that advanced against acid, namely, that it tends to remove metal also, and so shorten the life of the tubes. However, it is claimed that sand is less injurious; that might appear to be the case for the reason that very little sand is really employed per tube.

The accompanying illustration shows a form

of sand-blasting apparatus much used for cleaning of condensers. It consists of a nozzle that fits into the condenser tubes, a connection to the compressed air supply, a connection for connecting up to the plant water service, and an arrangement for feeding in the sand. The whole outfit can be made up cheaply, using a standard ¾-in. brass cock, ¾-in. iron pipe and some sheet iron for the sand funnel. The pipe for entering the condenser tubes should be case hardened, preferably. The illustration is self-explanatory. The sand funnel should have a diameter of about 6 ins. and a height of, say, 5 or 6 ins. A larger funnel than this makes the unit unwieldy to hold.

To clean condenser tubes with the equipment described the procedure is about as this: The water supply is cut down to a small rate of flow, a mere trickle. The nozzle of the cleaning tool is inserted into a condenser tube and held here while about one quart of sand is emptied into the sand funnel. The air is then turned on full blast as the sand slowly empties. It will take about 20 seconds for a quart of sand to be used, and this period of time can be taken as a guide if the funnel holds more than one quart of sand. At the rate of 20 seconds per tube and allowing for unforeseen contingencies, one man can clean about 100 tubes per hour. It might be pointed out that the use of one quart of sand per tube



Sand-Blasting Apparatus for Cleaning Condenser Tubes.

cannot shorten the life of the tube to any extent, so it is well not to use more sand, unless absolutely necessary. A sand blast will leave the condenser tubes with a bright surface and a heat conductivity practically equivalent to that of new clean tubes.

It is the water side of condenser tubes that become most coated with precipitate. Nevertheless, the steam side also becomes covered in some cases. One method of keeping the steam side of tubes clean and lessening corrosion is to employ kerosene. The kerosene can be fed into the turbine with the steam, in which case it tends to alleviate corrosion of the turbine blading due to condensation such as always occurs when a unit is shut down. The action of the kerosene on the condenser tubes (and turbine blades) is to cover the metallic surface with an oil film which prevents deposits from adhering and the corrosive action of air, carbonic acid, etc. This method of keeping surfaces clean was described in a recent Bureau of Mines bulletin on the subject of reducing corrosion of heating systems piping.

Sand can also be used on the steam side of the condenser tubes by forcing water through the condenser and charging this water with sand. This method has the advantage that it can be done quickly and the unit can be gotten ready for service again without loss of time. It is not very effective, it is thought.—W. H. D., Chicago.

No. 485.—Alternator Causes Flickering of Lamps.—In the plant where I work we have a 25-ampere 2300-volt, three-phase alternator driven by a 75-hp. Corliss engine, which we run on at peak periods. This unit is about 25 miles from the main plant. When the alternator comes in, bad flickering commences which does not stop until the alternator is cut off. What can be the cause and remedy? Cards taken on the engine show it to be all right and the alternator has the correct speed. I have cut off the steam on the engine and disconnected the valve gear, running the alternator as a synchronous motor, and the flickering is then worse than when the engine is carrying the load. The unit was first installed in the main generating plant before being moved and no trouble was experienced. Is hunting or unbalanced phases the cause?—E. A., Pine City, Minn.

Answer.—In analysing this problem it should be borne in mind that the alternators running at the correct speed does not indicate that a state of electrical synchronism exists between the two machines. A difference in time-phase positions of the two alternators will result in a transfer of power between the two machines, which cross power would tend to cause the condition complained of. That the alternators are not in a state of electrical synchronism is further borne out by the fact that the trouble is aggravated when the second machine is run as a synchronous motor, one of the characteristics of such a motor being that when corresponding amplitudes are not reached at the same instant a periodic phase shifting takes place.

The causes of an angular difference between the e.m.f.'s of two alternators are either mechanical or electrical. In the first class we have two reciprocating steam engines with an irregularity in their turning movements, due to steam distribution or inertia of the moving parts. These defects may be remedied by the use of a dash pot to render the governor sluggish, or by a heavier flywheel. As the trouble continues after the steam is shut off and the alternator is run as a motor it is safe to neglect mechanical causes.

In the second class we have hunting due to phase displacement which may be caused by the machines having windings of a different pitch, i. e., more coils per phase per pole in one than in the other, which would cause the wave forms to differ. This again is unlikely in the present case as the alternators had been successfully paralleled in their original location.

It is possible that the line between the two stations may introduce a peculiar effect due to inductance or capacity. Correct division of load is essential to proper paralleling. It appears that the proper procedure would be to isolate the smaller unit from the system and connect it to an artificial load and notice if the flickering takes place. If so, the trouble lies in this unit and has developed since it was moved and should be easily located and rectified. If the flickering should not take place when the machine is run separately it is evident that the interconnection is the cause. Over or under excitation is a possible cause of hunting.

Surrounding the pole pieces of the field with heavy copper rings may help, as this will introduce magnetic friction through eddy currents induced by field shifting and distortion, thus damping the oscillations.—J. S., Cumberland, B. C.

NEW APPLIANCES

Newly Developed and Improved Electrical and Mechanical Apparatus, Appliances, and Devices Now Being Placed on the Market

Small Ammeters for Automobiles.

The type B1 ammeter recently placed on the market by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., is applicable for use on automobiles, motor boats, yachts, small d-c. switchboards and for charging batteries. This instrument utilizes the portable vane construction, comprising a moving soft-iron vane polarized by a stationary permanent magnet and deflected over its scale by the action of a stationary current coil. No springs or moving coil are used, thus resulting in simplicity and ruggedness. The indications are made dead-beat by means of an efficient damper.

As the coil of this motor is located below the movement, the electromagnetic field from the coil does not pass through the magnet sufficiently to affect its strength at short-circuit cur-

Polarized Vane Ammeter.

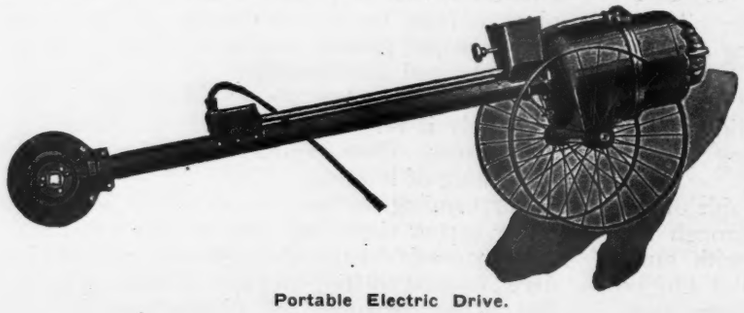
rent values according to the claims of the manufacturer.

The instrument is furnished in sizes of 0-15, 0-20 and 0-30 amperes.

Portable Electric Drive Can Be

A new portable electric drive placed on the market by the Toledo Pipe Threading Machine Co., Toledo, O., is meeting with considerable popularity.

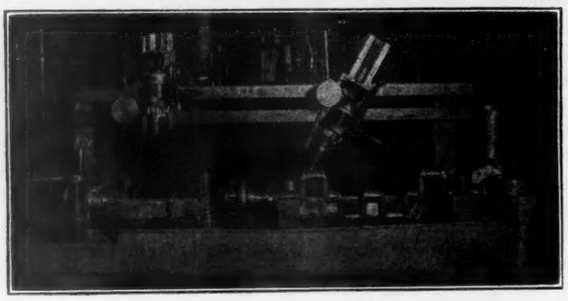
The "drive," being portable, can be wheeled about to different jobs on its light, strong carriage. The motors are of 1.5 hp. of special design, and are furnished for the necessary type of current. Each outfit includes 25 feet of flexible cable with a single plug connection for attachment at the switch box on the shaft housing. The "drive" is started and stopped by a specially designed push-button switch. It has a two-speed transmission gearing and the change from one speed to another is accomplished by pulling out or pushing in a knob.



Portable Electric Drive.

Unique Adaptation in the Use of Portable Electric Drills.

An interesting and novel device built and used in the Sterling Engine Co. plant at Buffalo, N. Y., has recently been called to notice. The device is designed to adapt a standard type of portable electric drill to the drilling of diagonal oil holes in the cranks of four-cycle marine engines.



Portable Electric Drill Used for Drilling Oil Holes.

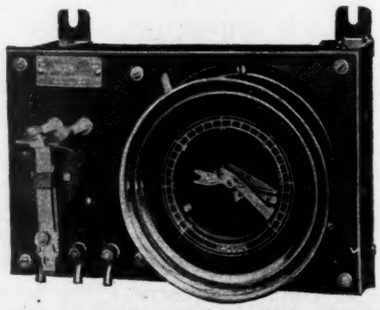
The table or bed is of cast iron, planed and provided with a longitudinal slot. Two V-blocks, with their centers in line with the drill spindler, slide in the slot. The two vertical members support the cross rail on which two carriages are mounted. Each carriage is provided with a slide to which a portable electric drill is attached. The crank is mounted in the V-blocks and drilled with diagonal holes as shown in the accompanying cut. An additional head is provided at the left hand side of the table for drilling the central oil hole.

Van Dorn portable electric drills built by the Van Dorn Electric Tool Co., Cleveland, O., are used in connection with this device.

Gauge-Type Pressure Regulator for Use With Motors.

A new gauge-type pressure regulator is being manufactured by the Cutler-Hammer Manufacturing Co., Milwaukee, to replace former gauge-type regulators. The new regulator consists of a pressure gage and relay mounted on a slate panel carried on a wall-type frame, and may be used on either a-c. or d-c. circuits. It is more durable than its former types of regulators, according to the manufacturer's claims.

This device is used as an automatic means of controlling the pilot circuits of automatic starters used with motors operating pumps, compressors, etc., and can be used on pressure systems above or below atmospheric pressure. As the pressure falls or rises the needle indicator in the pressure gauge makes contact with one of two adjustable contact points, thereby starting or stopping the motor when the pressure falls or rises to the points at which the contacts are set. The two contact points can be set as close as 5% of the total reading shown on the gauge, and are accessible



Gauge-Type Regulator for Motor Control.

for adjustment by unscrewing the glass cover of the dial. The gauge can be supplied with dials reading in various capacities, the smallest being 0 to 25 lbs. per sq. in., and the largest 0 to 10,000 lbs. per sq. in. Dials reading from 0 to 30 ins. of mercury below atmospheric pressure can also be provided. Gauges for ammonia service read from 0 to 300 lbs. per sq. in. and have operating mechanisms constructed of material which resists ammonia fumes.

The relay used in connection with the gauge has solid copper contacts, and will operate on either d-c. or a-c. circuits. The relay provides low-voltage release and wil operate to start the motor when the voltage returns.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

Steere Engineering Co., Detroit, Mich., is sending pamphlets to the trade telling the merits of the company's electrically welded steel pipe and fittings and cooling coils.

Electrical Repair Depot, 58 West Larned street, Detroit, Mich., has changed its name to the **Pioneer Electric Co.,** but remains under the same ownership and management as formerly.

Williamsport Wire & Rope Co., Williamsport, Pa., manufacturer of wire products, etc., has awarded a contract for the erection of a new 1-story plant building, about 100 by 140 ft., estimated to cost $60,000.

Roller-Smith Co., 233 Broadway, New York City, has issued a folder describing the new type HA pocket, portable ammeters, voltmeters and wattmeters for alternating current, manufactured by the company.

Crouse-Hinds Co., Wolf and Seventh streets, Syracuse, N. Y., manufacturer of condulets, etc., has arranged for the immediate construction of a new 1-story foundry addition, about 70 by 260 ft., for increased operations.

Griscom-Russell Co., 90 West street, New York City, has issued bulletin No. 1140, descriptive of the Stratton steam separator, in which reasons for the use of steam separators are given, together with details of construction and illustrations of the separators.

Electric Furnace Construction Co., Philadelphia, Pa., reports the successful starting up of a "Greaves-Etchells" electric furnace of one-half-ton capacity at the works of Charles Bertolus in Bellegarde, France, and of a 1-ton furnace at the works of Fonderie Ambrogio Necchi, Milan, Italy.

Cutler-Hammer Manufacturing Co., Milwaukee, Wis., manufacturer of electrical goods, etc., has completed negotiations for the purchase of the 5-story factory building of Winter & Co., manufacturer of pianos, located at Southern boulevard and 137th street, New York City. The structure aggregates about 100,000 sq. ft. of manufacturing space.

Jackson Electric Motor Repairing Co., Trenton, N. J., has completed arrangements for the inauguration of operations in its new local establishment at 38 Bellevue avenue, to specialize in the repair of motors and other electrical equipment. A complete plant with full machinery complement will be maintained for this work. W. J. Jackson is president of the company.

General Electric Co., Schenectady, N. Y., is reported to have completed negotiations for the acquirement of the plant of L. Feuchtwanger & Co., Little Ferry, N. J. It is understood that the property, which fronts on the Hackensack River, and comprises approximately 35,000 sq. ft. of manufacturing space, will be utilized by the Edison Lamp Works of General Electric Co. for increased operations.

Eureka Vacuum Cleaner Co., Detroit, Mich., had one of the largest displays on view at the Cleveland Electrical Show, March 10-20, and it is estimated that over 100,000 persons witnessed the demonstrations of the cleaner. The exhibition booth and demonstrations were under the managment of S. E. Applegate, representing the Detroit factory, who was assisted by J. H. Mansell, Ohio representative and R. E. Miller of the Eureka sales force. It was the first time the Eureka cleaners had been shown in any Ohio exhibition.

Demonstration Booth of the Eureka Vacuum Cleaner Co., Detroit, Mich., at the Cleveland Electrical Show, March 10-20.

Philadelphia Storage Battery Co., Ontario and C streets, Philadelphia, Pa., has inaugurated work on the rebuilding of its 3-story plant, recently destroyed by fire. The structure will be about 100 by 130 ft., and is estimated to cost $60,000. Stewart Brothers, 2526 North Orkney street, Philadelphia, are the contractors.

Electric Storage Battery Co., 19th and Allegheny streets, Philadelphia, Pa., has completed negotiations for the acquirement of a tract of property comprising about 40 acres on Rising Sun avenue, between Adams avenue and the Philadelphia & Frankford railroad, to be used as a site for the erection of a new plant. The works, details for which are being arranged, are estimated to cost in excess of $2,000,000.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., opened a cafeteria for its employes on April 6 that will seat 2600 people on the two main floors, while on the third floor is a dining room with a capacity of 500 and an auditorium with a seating capacity of 1000 persons. The new cafeteria is of reinforced concrete, 236 by 100 ft., and although three stories in height has no stairways on the main floors of the buildings. Gradual inclines or ramps are used exclusively in order to facilitate moving the diners from floor to floor. The first and second floors are devoted to cafeteria service, a section being reserved for women employes of the company. The auditorium has a stage 26 by 18 ft., complete with footlights, stage settings and a convenient dressing room. The cafeteria is equipped with the most modern labor-saving conveniences that are obtainable, including many electrically operated appliances.

Leeds & Northrup, Co., Philadelphia, Pa., describe a radically new method of hardening steel in a pamphlet entitled "The Hump Method for the Heat Treatment of Steel." Accurate measurement of temperatures and the independent determination of transformation points are rendered unnecessary by the new method. The work is heated in an electric furnace in contact with, or near to, a thermocouple. A recording instrument draws upon a large scale chart a curve of the e.m.f. developed by the thermocouple. While the work is passing through the transformation or decalescence point, the rise in temperature is arrested, producing a decided jog or "hump" in the line. The operator allows the work to remain in the furnace a definite number of minutes after this hump appears and then quenches. The results claimed are entire uniformity of heat treatment, including grain size, hardness and tensile strength, together with carbonization and scale.

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

H. H. TURNER, Walla Walla, Wash., has been elected a director of the Pacific Power & Light Co., Portland, Ore.

M. KESSLER, formerly connected with the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has become superintendent at the plant of the Athol Machine Co., Athol, Mass.

E. S. WEST, manager of power of the Bethlehem Steel Corp., Bethlehem, Pa., tendered an interesting address before the engineering students of Johns Hopkins University, Baltimore, Md., on March 31.

GEORGE A. CAMPBELL, manager of the Reno Power, Light & Water Co., Reno, Nev., and president of the Nevada Highway Association, has been appointed a member of the Nevada State Department of Highways.

R. E. UPTEGRAFF has discontinued his services with the Adams-Bagnall Electric Co., Cleveland, O., and will again take up his work in Pittsburgh, Pa., with the firm of Rutherford & Uptegraff, consulting electrical engineers.

O. B. FRANK, for three years manager of the properties of Douglas County Light & Water Co., Roseburg, Ore., retired from that position April 1, and was succeeded by R. M. JENNINGS, who formerly was connected with H. M. Byllesby & Co., Chicago, Ill.

H. R. WEST, recently appointed instructor in the electrical engineering department of the University of Pennsylvania, Philadelphia, Pa., is a graduate of the University of South Dakota, and was formerly employed in the transmission department of the Bell Telephone Co. of Pennsylvania.

GEORGE M. OGLE, formerly chief electrical engineer of the United States Shipping Board Emergency Fleet Corp., is now a member of the engineering organization in charge of the electrical contracting and consulting engineering department of the Vulcan Iron Works, Inc., Jersey City, N. J.

RICH D. WHITNEY, associate professor of electrical engineering, Syracuse University and consulting engineer of the Bureau of Water, Syracuse, N. Y., has resigned these positions to take up work with the H. H. Franklin Manufacturing Co., Syracuse, where he will be attached to the office of the factory manager and will work on special assignments.

GEORGE L. MYERS, who has been connected with the Pacific Power & Light Co., Portland, Ore., for several years, has been made assistant to President Guy W. Talbot. Mr. Myers is one of the vice-presidents of the Northwest Electric Light and Power Association, and is a member of the executive, public policy and other committees of that organization.

J. L. RAY has been promoted to power apparatus sales manager of the Western Electric Co., with headquarters at the general sales department, New York City. He was formerly manager at the Pittsburgh, Pa., office and has been succeeded as manager there by W. H. MACCRELLISH, who, until his promotion, had charge of the Buenos Aires, Argentine Republic, office of the company.

GEORGE BAILY, formerly manager of the supply division of the Cincinnati office of the Westinghouse Electric & Manufacturing Co., has been appointed

George Baily.

industrial assistant to manager of the supply department of that company at East Pittsburgh, Pa. Born and educated in Baltimore, Md., Mr. Baily served on an engineering corps in Baltimore, and on the U. S. Engineering Corps in defense of Baltimore Harbor in 1898. Later he spent considerable time with the U. S. Geological Survey. After graduating from Lehigh University in the class of 1904 as a civil engineer, he became associated with the Dravo Construction Co., of Pittsburgh, where he remained until 1910, at which time he went into business for himself in Cincinnati as sales agent and contracting engineer. He remained at this occupation until 1913, when he joined the Westinghouse organization. During the war he served as a major of engineers, U. S. Army.

RUSSELL P. ASKUE has severed his connection with the publicity department of the National Lamp Works, Cleveland, O., to go into agency work with headquarters at Cleveland. Mr. Askue has been with the National Lamp Works for several years, prior to which he was advertising manager for the Ivanhoe-Regent Works of General Electric Co.

G. E. STOLTZ, general engineer, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has been appointed engineer in charge of the steel mill section of the engineering department. After graduating in the electrical engineering course of Ohio State University in 1909, Mr. Stoltz entered the apprenticeship course of the Westinghouse company, after which he became engaged in steel mill work.

HAMMOND D. BAKER, a graduate in electrical engineering of the Alabama Polytechnic Institute, has been appointed manager of the Detroit, Mich., office of the Roller-Smith Co., 233 Broadway, New York City. During the world war Mr. Baker was in the government aviation service as a second lieutenant. On leaving the service he joined the forces of the United Motors Corp. and later joined the sales department of the Hoskins Manufacturing Co., of Detroit, from which concern he resigned to accept the position with the Roller-Smith Co.

DR. WILLIAM C. HUNTINGTON has been appointed commercial attache to Paris by the Bureau of Foreign and Domestic Commerce. Dr. Huntington entered the service of the bureau in 1915 as manager of the district office in Chicago, and in the following year was made commercial attache to the embassy of Petrograd, where he remained until after the second revolution, when he returned to Washington and organized the Russian division in the bureau. After graduating from the school of engineering of Columbia University, Dr. Huntington spent four years as a metallurgist with an American steel corporation, and then went abroad and studied for three years in France, Belgium and Germany, taking the degree of Doctor of Engineering in the Royal Technical College of Aix-La-Chapelle, France, in 1914. During this period he visited and worked in manufacturing plants in France, Belgium and Germany, and became acquainted with Alsace-Lorraine, the Saar district, and what is now the occupied territory. He speaks French, German and Russian.

OBITUARY.

FRANCIS E. HURLBURT, formerly chief electrical inspector for the New York Board of Fire Underwriters, died on April 2 at his home in Brooklyn, N. Y.

ALBERT PERCY CHAPMAN died at Ludlow, Mass., on March 18 following a short illness with pneumonia. He was born in Springfield, Mass., Feb. 5, 1883, and was a graduate of the Springfield High school and Worcester (Mass.) Polytechnic Institute. In 1914 he took charge of the electrical work for the Ludlow Manufacturing Co., and became superintendent of power and repairs in 1917, which office he held at the time of his death. He was a member of the American Institute of Electrical Engineers.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Woonsocket, R. I.—Bernon Worsted Co., Park avenue, is considering plans for the erection of a large addition to its plant, to approximately double the present capacity. The structure will be about 78 by 170 ft., and considerable electrical equipment will be required. Lawrence A. Jarrett is treasurer and manager of the company.

New Haven, Conn.—National Folding Box Co. has awarded a contract to C. W. Blakeslee & Son, Waverly street, New Haven, for the proposed alterations and improvements in its power plant at Alton and James streets.

New Haven, Conn. — Charles Wimpfheimer has awarded all contracts for the construction of his proposed new local silk mill to the Sperry Engineering Co., New Haven. The works include a 4-story main manufacturing building, about 80 by 200 ft.; weave shed, 126 by 200 ft.; and power plant, about 40 by 90 ft., for factory service. Large quantities of electrical equipment, including motors for individual drive, etc., will be required at the plant. The company plans for the completion of the works by early fall.

Brooklyn, N. Y.—Contract has been awarded to the Gillies-Campbell Co., 101 Park avenue, New York City, for the construction of a 4-story telephone exchange plant of the New York Telephone Co., at Liberty avenue and Milford place, 60 by 120 ft., estimated to cost $200,000.

Buffalo, N. Y.—John F. McDonald has made an offer to the city council of a site at Niagara Falls, to be used in connection with the proposed establishment of a municipal electric power plant at Buffalo. The water supply at this location is estimated to provide for a plant of about 260,000-hp. capacity.

Churchville, N. Y.—The State Public Service Commission has granted permission to the town officials to construct and operate an electric light and power plant for municipal service.

Herkimer, N. Y.—The Municipal Commission, Michael Foley, president, is having plans prepared for the construction of a 1-story addition, about 40 by 60 ft., to the municipal electric power plant, as well as the installation of a quantity of new equipment. The work is estimated to cost $160,000, and a bond issue to cover the project has been authorized.

Mt. Vernon, N. Y.—Supreme Dye & Cleaning Co. has had plans prepared for alterations and improvements in its 2-story boiler plant, about 45 by 60 ft., at 12th avenue and Third street. The work is estimated to cost about $10,000.

New York, N. Y.—New York Telephone Co., 15 Dey street, has had plans prepared for alterations and improvements in its telephone exchange buildings at 422 West 58th street, and 93 Broad street, estimated to cost $33,000 and $12,000, respectively. The company has also completed foundations in connection with the construction of a new addition to the exchange at Astoria, L. I.

New York, N. Y.—New York Edison Co., Irving place and 15th street, has filed plans for the construction of a new 2-story reinforced concrete transformer station, about 91 by 112 ft., on Inwood avenue, near 170th street, to cost about $250,000. In connection with the company's new transformer station on 6th street it is proposed to install a total of four new 4000-kw. rotaries with auxiliary equipment.

Olean, N. Y.—Day & Zimmerman, 611 Chestnut street, Philadelphia, Pa., has acquired a controlling interest in the Western New York & Pennsylvania Traction Co., Olean. Gordon Campbell, Philadelphia, has been appointed president of the company, succeeding Wilson R. Page, Olean.

Queens, L. I., N. Y.—Borough officials have awarded a contract to the Fox, Reynolds Co., 81 East 125th street, New York City, for the construction of a new electric pumping station at Sutter and North Conduit avenues, Queens, as well as the installation of equipment, estimated to cost approximately $175,000. Maurice E. Connolly, Queens Subway building, Long Island City, is president of the company.

Rochester, N. Y.—Eastman Kodak Co., Kodak park, has awarded a contract to the Fred T. Ley Co., Springfield, Mass., for the construction of the new power plant at its works. The structure, which is estimated to cost $200,000, including machinery and equipment, will be utilized in connection with the expansion plans of the company.

Rochester, N. Y.—The Tuscarora, Brockport, Bergen, Interlake & Nunda Telephone companies have been merged with the Rochester Telephone Co.

Sardinia, N. Y.—Holland-Sardinia Light & Power Corp. has petitioned the State Public Service Commission for permission to construct electric light and power lines for the furnishing of electrical energy for light, heat and power purposes in Holland, Chaffee, Protection, and Sardinia. The company is capitalized at $150,000, and it is proposed to construct a hydroelectric plant and dam on Sardinia creek.

Utica, N. Y.—Utica Gas & Electric Co. has filed notice with the Secretary of State of an increase in its capitalization from $4,500,000 to $8,500,000, for general business expansion.

Camden, N. J.—Large quantities of electrical and mechanical equipment will be required in connection with the construction of the new pier by the harbor commission, at the foot of Spruce street, Delaware river. The work will include wharf and warehouse, as well as a pier, and the machinery installation will comprise complete loading and unloading equipment as well as a large electrically operated traveling crane.

Newark, N. J.—Beaver Engineering Co., 59 Mechanic street, has been awarded a contract by the Board of Education for electrical work in connection with the erection of the new Franklin School building, at a cost of $397,600. This electrical work will cost $12,474.

Trenton, N. J.—The city commission has perfected plans for the proposed improvements in the electric street-lighting system in the outlying sections and center of the city. The work provides for the installation of 600-cp. Mazda C lamps to replace the present arc-lighting units, as well as a total of 366-400-cp. Mazda C lamps and 250-100-cp. lamps in the outlying districts. Professor C. E. Clewell, the city's lighting expert, is preparing plans for the lighting of upper Stacy Park, and it is said that specifications are being arranged for the installation of an entirely new street-lighting system throughout the city to cost approximately $500,000, though this latter work will be held in abeyance by the city commission until a later date.

Allentown, Pa.—Arbogast & Bastian Co., 1 Hamilton street, is rushing to completion the construction of its new steam operated power plant adjoining its works on North Front street. The structure, when completed, will represent an expenditure of about $200,000, including machinery and equipment.

Allentown, Pa.—Contract has been awarded by the city to the Hazard Manufacturing Co., Wilkesbarre, for the furnishing of about 3220 feet of underground cable to be used for the police, fire and telegraph systems.

Carlisle, Pa.—E. C. Beetem & Sons have broken ground for the construction of a new 1-story power plant, about 46 by 46 ft., at its works on East Leuther street, estimated to cost $50,000, including machinery and equipment. H. H. Burrell, 301 Quince street, Philadelphia, is the building contractor.

Catasaqua, Pa. — The borough council has completed the installation of a new electric street-lighting system throughout the municipality. Electrical energy is furnished by the Lehigh Valley Light & Power Co.

Gettysburg, Pa. — The borough

council is said to be considering plans for the installation of a new municipal electric light and power plant. Electrical energy at the present time is furnished by the Hanover Light Co.

Harrisburg, Pa.—The city council has authorized Dr. S. F. Hassler, Superintendent of the Department of Public Safety, to retain an engineer for the arrangement of plans and specifications for extensions and improvements in the city waterworks system. The work will include considerable new equipment, comprising 400-hp. boiler at the pumping station; new pumping machinery with capacity of about 15,000,000 gals. daily; engine, filtering apparatus, electrical equipment, and auxiliary apparatus.

Munhall, Pa.—Duquesne Light Co., Pittsburgh, Pa., has taken bids for the construction of a new 1-story station, about 37 by 60 ft., for increased operations.

Philadelphia, Pa.—Fire, April 7, destroyed the boiler plant and damaged the works of the Keystone Woodenware Co., 617 Reed street, to the extent of about $50,000, including a quantity of finished material, estimated at $20,000. It is understood that the company will arrange for immediate rebuilding.

Philadelphia, Pa.—Fire on April 7, caused by the explosion of a boiler unit, damaged the generating plant of the Philadelphia Electric Co., 908 Sansom street. The company has made arrangements for repairs to the destroyed sections.

Philadelphia, Pa. — The Pennsylvania Equipment Co., 1420 Chestnut street, J. E. Bough, manager, is in the market for one 1250 or 1500-kw. and one 2250 or 2500-kw. a-c. generators and two 1750 or one 3500-kw. maximum rating, three-phase, 60-cycle, 480-volt turbogenerator.

Pittsburgh, Pa.—Peoples Ice Co. has awarded a contract to the W. T. Grange Construction Co., Pittsburgh, for the construction of its new plant, to be located at Friendship avenue and Pearl street. The works will include a 1-story brick and steel ice manufacturing department, about 101 by 237 ft., as well as a structure for ice storage purposes, and considerable electrical equipment, refrigerating apparatus, etc., will be required. The project is estimated to cost about $165,000.

Waynesboro, Pa.—The Waynesboro Electric Co. has inaugurated work on the conversion of its present 22,000-volt power line extending into the mountain districts in this vicinity to 33,000 volt capacity.

Milford, Del.—The town council is considering plans for alterations and improvements in the municipal electric lighting system, the work being estimated to cost about $20,000.

Washington, D. C.—Potomac Electric Power Co. has filed plans for alterations and improvements in its substation building at 438 Washington street, to facilitate operations. The work is estimated to cost about $17,000.

Big Stone Gap, Va.—F. Y. Kitmiller Co., Bechtelsville, Pa., contemplates the erection of five silk mills in the following cities: Big Stone Gap, Appalachia, Norton, Pennington Gap and Gate City. The project will involve an expenditure of about $500,000.

Scottsville, Va.—Scottsville Power Corp., recently organized with a capital of $100,000, is arranging for the development of water power on the upper sections of the James River, for the furnishing of electrical energy to Scottsville, Richmond, Lynchburg, Roanoke, Charlottesville, Staunton and Orange. It is understood that the company is planning to increase the capital to $1,000,000. John L. Pitts, Scottsville, is president; W. H. Langhorn, Warren, Va., vice-president, and Linsey Pitts, Scottsville, secretary, of the company.

Logan, W. Va.—The Guyan Machine Shops, B. Shell, manager, is in the market for two 400-kv-a., 2200-volt, three-phase, 60-cycle turbogenerators, complete, with watertube boilers, condensers, cooling tower, switchboard, pumps and lightning arresters.

Gastonia, N. C.—Plans are being arranged by the city for improvements and extensions in the municipal electric light, power and water systems, for increased operations. It is proposed to issue bonds for $285,000 to cover the cost of the proposed work. S. G. Fry is city clerk.

Union, S. C.—The city council is considering the issuance of bonds for $30,000, to provide for extensions and improvements in the municipal electric lighting system.

Tampa, Fla.—The city will make additions to its lighting system.

NORTH CENTRAL STATES.

Lisbon, O.—The Ohio Gas & Electric Co. is arranging to extend its lines on Canton road and also to Willow Grove park. A line will also be run to Elkton and other outlying districts.

Millerburg, O.—H. E. Pyers, Pittsburgh, Pa., has asked the city council for a franchise for the purpose of establishing an electric light and power plant.

Brazil, Ind.—The G. & R. Foundry Co., Terre Haute, which recently purchased the Crawford and McCrimmon foundry and machine shops in Brazil, is constructing three large additions to the foundry and increasing the working force to 300 men.

Elwood, Ind.—The Elwood Canning Co. will erect a new building of structural steel to cost $28,000, to take the place of one recently destroyed by fire.

Griffith, Ind.—The Griffith Foundry Co. has increased its capital stock from $50,000 to $150,000.

Indianapolis, Ind. — The Pioneer Brass Works has increased its capital stock from $70,000 to $100,000.

Indianapolis, Ind. — The General Tool & Gauge Co. has increased its capital stock from $20,000 to $100,000.

Indianapolis, Ind.—The Chapman-Price Steel Co. will rebuild the plant which burned March 17. The buildings will consist of a rolling mill, with a motor of 1200-hp. capacity, to be housed in two 1-story steel buildings, 80 by 300 ft.; the steel galvanizing department, to be housed in two buildings of similar construction, one 60 by 240 ft. and the other 180 by 240 ft., and the company office building. The company will start with 375 employes. The improvements will result in an expenditure of $1,000,000.

Portland, Ind. — The Portland Forge and Foundry Co. has increased its capital stock from $100,000 to $200,000.

Bloomington, Ill.—Campbell, Holton and Co. has awarded contract for the erection of a new addition to their present plant to cost $65,000.

Taylorville, Ill.—The citizens will vote April 29 on a bond issue of $80,000 for the erection of a municipal lighting plant for the city.

Mattoon, Wis.—T. L. Kratz is to build and operate an electric light and power plant in this city.

Milwaukee, Wis.—Northwest University is to have a new science and engineering building at 13th street and Grand avenue. The estimated cost is $60,000.

Duluth, Minn.—The Diamond Calk Horseshoe Co. will erect a $50,000 warehouse and office building. J. J. Wangerstein is the architect on the project.

Davenport, Ia.—The capital stock of the Foulless Spark Plug Co. has been increased from $100,000 to $200,000.

Maquoketa, Ia.—The Iowa Electric Co., which operates power and light transmission lines out of Maquoketa, has petitioned the Scott County Board of Supervisors for a franchise to run a power line along the county road from Big Rock to Allen's Grove. The company has already applied to the Clinton County Supervisors for permission to run continuous lines through Welton Township. The Scott county franchise asked by this company will also include rights to operate in the town of Big Rock.

Newton, Ia.—Building operations for the Newton Foundry Co., recently organized with $250,000 capital stock, are to start soon.

Kansas City, Mo.—Fiftieth street, from Brooklyn to Prospect avenue, will be the scene of a trial of a new street-lighting system. Plans have been made and an ordinance has gone to the city council for a system of single 400-cp. tungsten lamps. The lamps will be placed on trolley pole brackets, four to the block.

Kansas City, Mo.—The Lysle Milling Co., Leavenworth, Kan., is to build a 3,000-barrel capacity flour mill in Kansas City.

Kansas City, Mo. — Committees were named at a meeting of the South Main Street Improvement Club to ascertain the character of the lighting system soon to be installed between Armour boulevard and 39th street, and also to see if the illumination can not be extended to Westport avenue or 43rd street.

St. Joseph, Mo.—The St. Joseph Brewery Co., William R. Lange, pres-

ident, will remodel its plant for the purposes of manufacturing artificial ice. The improvement will cost $50,000, and will include the installation of considerable electrical apparatus.

St. Louis, Mo.—The Union Electric Light & Power Co. has arranged for the issuance of bonds for $2,500,000, to provide additional working capital and general business expansion. H. Spoher is secretary and treasurer of the company.

Auburn, Neb.—The village of Johnson will vote on a bond issue for the purpose of building a transmission line to Auburn or to the Graf terminus of the Tecumseh light system.

SOUTH CENTRAL STATES.

Ashland, Ky.—The Boyd County Electric Co. has filed notice with the Secretary of State of an increase in its capitalization to $220,000, to provide for general business expansion.

Albany, Ala.—A syndicate headed by R. F. Willingham, Macon, Ga., will erect a cotton press costing $250,000 on West Fulton street, Albany.

Birmingham, Ala.—The city commission has granted a petition of the Sheffield-Sloss Steel & Iron Co. authorizing the construction of a transmission line from the North Birmingham furnace to the Sloss ore mines, below Bessemer. This work is a part of the general electrification of all Sheffield-Sloss properties being done at a cost of $1,500,000.

Vida, Ala.—The Alabama Power Co. has had plans prepared for the construction of a new 44,000-volt transmission line extending from Vida to Selma, Ala., a distance of about 30 miles. W. E. Mitchell, Birmingham, Ala., is assistant general manager of the company.

Crystal Springs, Miss.—The city has issued bonds for the improvement of the water and lighting facilities. About $15,000 will be spent on the electric light plant.

Laverne, Okla.—The city council is having plans prepared for the construction of a new power plant, about 30 by 80 ft., to be used for municipal service. In connection with the work, arrangements are being made for the installation of a local transmission system. Claude H. Arbuthnot is engineer in charge of the project.

Alvin, Tex.—The Alvin Ice, Light and Power Co. will install complete machinery and equipment for the manufacture of ice.

Caldwell, Tex.—The Caldwell Electric Power & Ice Co. has increased its capital stock from $10,000 to $40,000.

Columbus, Tex.—The Columbus Electric Light Co. is arranging to enlarge its plant and to build a power transmission line to Giddings. The company serves the town and private consumers of Columbus.

Corpus Christi, Tex.—The Corpus Christi Railway and Electric Light Co. has had plans prepared for the rehabilitation of its property at an estimated cost of about $125,000. The city commission has granted the company a new 30-year franchise. The property of this company was badly damaged by the severe tropical storm which swept over Corpus Christi last September.

Dallas, Tex.—The Dallas Power & Light Co. will construct a spray pond and cooling system here to cost $107,000.

Dallas, Tex.—The American Public Service Co. of Dallas has submitted a proposition to the city of Abilene to take over, rehabilitate and operate the street railway system there. If the deal is consummated the company will spend about $50,000 in improvements, it is stated.

Dallas, Tex.—According to E. H. Pratley, city electrician, a new system of ornamental lights is being planned to replace the present one on Main, Elm and Commerce streets. It is purposed that the new lights be on poles from which the arm extensions have been eliminated. About 200 new poles will be required and the cost of each pole will be approximately $70, it is stated.

Denison, Tex.—Taxpayers of Denison have voted $244,000 bonds, the proceeds to be used in purchasing and installing electrical pumping machinery at the two municipal pumping plants and constructing a new lighting system here.

Waco, Tex.—It is stated by O. A. Ryfle, president and general manager of the Central Texas Electric Railway Co., that contracts will be let soon for the construction of the first division of the proposed road between Waco and Temple. This line is projected to run from Waco to San Antonio, 182 miles, via Temple, Austin and a number of smaller towns. Its principal offices are in Waco.

Wichita Falls, Tex.—The Chamber of Commerce, working with electrical engineers, has adopted a plan for ornamental street lighting which will be put into effect in the near future.

WESTERN STATES.

Crawford, Colo.—The Crawford Mill & Electric Light Co., recently organized, has started work on a 2-story building.

Denver, Colo.—Clyde B. Spangler and H. L. Thompson contemplate the erection of a hydroelectric plant to furnish electrical energy for the San Luis Valley plant to be located on the Rio Grande River, between Del Norte and Creede.

Twin Falls, Ida.—Plans have been completed for the erection of a 5-story, fireproof hotel to cost $315,000. William G. Reed is the contractor for the work.

Blaine, Wash.—Chief Engineer Eddy and General Freight and Passenger Agent W. D. Power, both of the British Columbia Electric railway, were here recently to confer with local people regarding the extension of the company's line from Cloverdale, B. C., to this place.

Vancouver, Wash.—The Spirit Lake Railway & Power Co. will erect a powerhouse at Spirit Lake to cost $2,000,000.

Yakima, Wash.—The Pacific Power & Light Co. will expend $30,000 in improving its plant.

Roseburg, Ore.—The city will vote on May 21 on the proposal to authorize the issuance and sale of bonds amounting to $500,000, to finance the proposed project of building a hydroelectric plant on the Umpqua River, the installation of a pumping plant, and the laying of a pipe line for additional city water supply.

Los Angeles, Cal.—The Vegetable Oil Products Co. contemplates the erection of a plant in units to cost approximately $300,000.

INCORPORATIONS.

Washington, D. C.—Medical Appliance Corp. Capital, $150,000. To manufacture electrically-operated medical appliances.

New York, N. Y.—Easy Phone Co. Capital, $20,000. To manufacture telephone equipment, etc. Incorporators: S. Mann, E. M. Harlam and H. Rosenoon, 1133 Broadway.

New York, N. Y.—Specialty Art Lamp Co. Capital, $10,000. To manufacture lamps, etc. Incorporators: B. E. Kopelman, J. Gershtenson and J. Goodman, 1770 Madison avenue.

Rockville Centre, N. Y.—Oxyhydrocarbon Heating Co. Capital, $100,000. To manufacture heating equipment. Incorporators: A. L. Turner, W. L. Colt and J. G. Gerhard, 222 West 34th street, New York City.

Utica, N. Y.—Wells-Winterbottom Electric Co. Capital, $10,000. To operate a local electric plant. Incorporators: E. J. and S. Winterbottom and C. H. Wells, Utica.

Newark, N. J.—National Transmitter Co. Capital, $100,000. To manufacture telephone apparatus. Incorporators: Thomas J., Arthur R. and Jerome J. Dunn.

Elizabeth, N. J.—Franklin Appliance Co. Capital, $50,000. To manufacture electrical supplies, etc. Incorporators: Frank and Arthur D. Stout, and C. L. Hight.

Pittsburgh, Pa.—Ideal Electric Heater Co. Capital, $100,000. To manufacture electrically operated heating appliances, etc. Incorporators: W. I. N. Lofland, Mark W. Cole, Dover, Del., and Wilber A. McCoy, Pittsburgh.

Mounds, Okla.—Mounds Fuel & Light Co. Capital, $10,000. To operate a local electric light and power plant. Incorporators: H. M. and Joseph Walker, and M. V. McAtee.

Huntertown, Ind.—The Huntertown Telephone Co. has been incorporated with capital stock of $25,000 to operate telephone lines and exchanges. The directors are Charles H. Harting, F. E. Emrich and John Emrich.

Newcastle, Tex.—Newcastle Light & Power Co. Capital, $50,000. To operate a local plant for the generation and distribution of electrical energy. Incorporators: W. S. Husted, W. Fred Nance, and A. C. Bentley.

Jersey City, N. J.—Jersey City Storage Battery Co. has filed notice of organization to operate at 2381 Boulevard for the production of storage batteries. Lee L. Kelts, H. S. Cook, and Walter P. Lightfoot, 201 Claremont avenue, Jersey City, head the company.

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

April Dividend Payments Will Total $356,920,878.

Interest and dividend disbursements in April will amount to $356,920,878, according to the New York Journal of Commerce. This compares with $353,871,177 in April, 1919. Stockholders will receive in the aggregate $95,265,595, compared with $91,518,420 in April, 1919. Interest payments will approximate $261,655,283, compared with $262,352,757 in April, 1919. The government will pay out in interest $145,355,283, of which $142,152,853 represents the semi-annual interest on the fourth Liberty 4½% bonds, compared with $151,152,757 in 1919, the decrease being due to redemptions. Corporations will pay out in the way of interest $116,300,000, compared with $111,200,000 in the corresponding period of a year ago, the increase being the result of new bond and note issues. The following is a summary of the April dividends with comparisons:

	1920.	1919.
Industrial and miscellaneous companies	$63,940,350	$60,260,315
Steam railroads	23,310,120	23,307,920
Street railways	8,015,125	7,950,185
Total	$95,265,595	$91,518,420

Chicago City Railway Co.

Chicago City Railway Co. has issued its annual report for the year ended Dec. 31, 1919, showing net income after all charges of $1,303,937, equivalent to $7.24 a share ($100 par value) earned on the $18,000,000 capital stock, as compared with net income of $846,186, or $4.70 a share, earned on the capital stock in 1918. Income account for the year ended Jan. 31, 1919, compares as follows:

	1920.	1919.
Net earnings	$ 806,525	$ 10,650
City's share	443,589	5,858
Company's share	*$ 342,975	$ 4,792
Interest on capital invested	2,705,676	2,668,658
Operating income	$3,048,651	$2,673,450
Other income	36,170	†72,047
Total income	$3,084,821	$2,601,403
Bond interest	1,780,884	1,755,217
Net income	$1,303,937	$ 846,186
Dividends	900,000	900,000
Surplus	$ 403,937	‡$ 53,814

*After excluding $19,961 Southern Street Railway Co.'s proportion as per ordinance. †Debit. ‡Deficit.

Northern Ohio Electric Corp.

Earnings of the Northern Ohio Electric Corp. and its subsidiary companies for February and the 12 months ended Feb. 29, 1920, compare with 1919 as follows:

	1920.	1919.	Changes. Inc.
Feb. gross	$ 869,220	$ 673,934	$255,290
Net earnings	201,055	223,127	77,928
Surplus after fixed charges	114,242	60,824	53,418
Balance after pfd. divs.	84,242	30,824	53,418
12 months' gross	9,679,003	7,582,451	1,826,552
Net earnings	3,227,002	2,575,077	651,925
Surplus after fixed chgs.	1,222,539	759,601	462,938
Balance after pfd. divs.	862,539	399,601	462,938

Winnipeg Electric Railway Co.

Winnipeg Electric Railway Co.'s income account for the year ended Dec. 31, 1919, compares as follows:

	1919.	1918.
Gross earnings	$4,284,479	$3,558,723
Net operating revenue	1,264,984	1,176,496
Gross income	1,323,623	1,221,428
Surplus after charges	96,805	289,784

Kansas Gas & Electric Co.

Earnings of the Kansas Gas & Electric Co., a subsidiary of the American Power & Light Co., for December and the twelve months ended Dec. 31, 1919, compare with 1918 as follows:

	1919.	1918.	Changes. Inc.
Dec. gross	$ 293,255	$ 254,720	$38,535
Net after taxes	96,890	91,331	5,559
Total income	96,330	95,695	635
Surplus after int. charges	51,212	51,104	108
12 months' gross	2,667,516	2,123,556	543,960
Net after taxes	783,998	691,593	92,405
Total income	785,091	709,434	75,657
Surplus after int. charges	306,680	307,634	*954
Balance after pfd. divs.	162,189	174,634	*12,445

*Decrease.

Nashville Railway & Light Co.

The earnings of the Nashville Railway & Light Co. for January and the 12 months ended Jan. 31, 1920, compares with 1919 as follows:

	1920.	1919.
January gross	$ 306,903	$ 272,317
Net after taxes	76,980	81,286
12 months' gross	3,258,970	2,934,009
Net after taxes	783,782	377,674
Bal. after pfd. div.	183,475	372,114

Columbia Gas & Electric Co.

The Union Gas & Electric Co., controlled by the Columbia Gas & Electric Co., report earnings for February, 1920, as compared with February, 1919, as follows:

	1920.	1919.
February gross	$ 979,384	$ 782,573
Net earnings	400,381	271,830
Sur. fixed charges	195,831	116,355

Northern States Power Co.

The combined earnings of Northern States Power Co. properties are reported as follows for the month of February and the 12 months ended Feb. 29, 1920, compared with corresponding previous periods:

Month of February:	1920.	1919.
Gross earnings	$ 984,145	$ 858,076
Net earnings	398,111	364,554
12 months ended Feb. 29:		
Gross earnings	10,146,278	8,687,378
Net earnings	4,192,620	3,736,818

Twin City Rapid Transit Co.

Earnings of the Twin City Rapid Transit Co. for the month of February, 1920, compares with February, 1919, as follows:

	1920.	1919.	Changes. Inc.
Feb. gross	$ 984,939	$ 829,499	$155,440
Net earnings	210,682	190,858	19,824
Surplus after fixed charges and taxes	32,050	43,691	*11,641

*Decrease.

Dividends.

The Duluth Edison Electric Co. has declared its regular quarterly dividend of 1½% on the preferred stock, payable April 1 to stockholders of record March 20.

The Northern States Power Co. has declared its regular quarterly dividend of 1¾% on the preferred stock, payable April 20 to stockholders of record March 31.

The Ottumwa (Ia.) Railway & Light Co. has declared its regular dividend of 1¾% on the preferred stock, payable April 15 to stockholders of record March 31.

WEEKLY COMPARISON OF CLOSING BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeiler & Co., Rookery Bldg., Chicago.

	Div. rate. Per cent.	Bid Apr. 6.	Bid Apr. 13.
Public Utilities—			
Adirondack Electric Power of Glens Falls, common	6	8	10
Adirondack Electric Power of Glens Falls, preferred	6	74	75
American Gas & Electric of New York, common	10+extra	124	120
American Gas & Electric of New York, preferred	6	37	38
American Light & Traction of New York, common	..	186	184
American Light & Traction of New York, preferred	6	88	88
American Power & Light of New York, common	4	63	61
American Power & Light of New York, preferred	6	70	69
American Public Utilities of Grand Rapids, common	..	4	5
American Public Utilities of Grand Rapids, preferred	7	16	13
American Telephone & Telegraph of New York	..	104	103
American Water Works & Elec. of New York, common	..	3	2
American Water Works & Elec. of New York, particip	7	7	7
American Water Works & Elec. of New York, first preferred	..	45	45
Appalachian Power, common	..	2	1½
Appalachian Power, preferred	7	17	17
Cities Service of New York, common	+extra	390	385
Cities Service of New York, preferred	6	69	69
Commonwealth Edison of Chicago	8	106	105
Comm. Power, Railway & Light of Jackson, common	..	22	23
Comm. Power, Railway & Light of Jackson, preferred	6	49	49
Federal Light & Traction of New York, common	..	6	6
Federal Light & Traction of New York, preferred	..	44	45
Middle West Utilities of Chicago, common	..	19	19
Middle West Utilities of Chicago, preferred	..	40	39
Northern States Power of Chicago, common	..	49	47
Northern States Power of Chicago, preferred	ex.div.7	86	85
Pacific Gas & Electric of San Francisco, common	..	50	50
Public Service of Northern Illinois, Chicago, common	7	78	78
Public Service of Northern Illinois, Chicago, preferred	6	83	83
Republic Railway & Light of Youngstown, common	4	18	17
Republic Railway & Light of Youngstown, preferred	6	54	54
Standard Gas & Electric of Chicago, common	..	19	18
Standard Gas & Electric of Chicago, preferred	6	39	39
Tennessee Railway, Light & Power of Chattanooga, common	..	2	1
Tennessee Railway, Light & Power of Chattanooga, preferred	6	6	5
United Light & Railways of Grand Rapids, common	4	25	24
United Light & Railways of Grand Rapids, preferred	6	..	62
Western Power of San Francisco; common	..	17	17
Western Union Telegraph of New York	extra	82	82
Industrials—			
Electric Storage of Philadelphia, common	4	107	106
General Electric of Schenectady	8	175	175
Westinghouse Electric & Mfg. of Pittsburgh, common	7	53	53